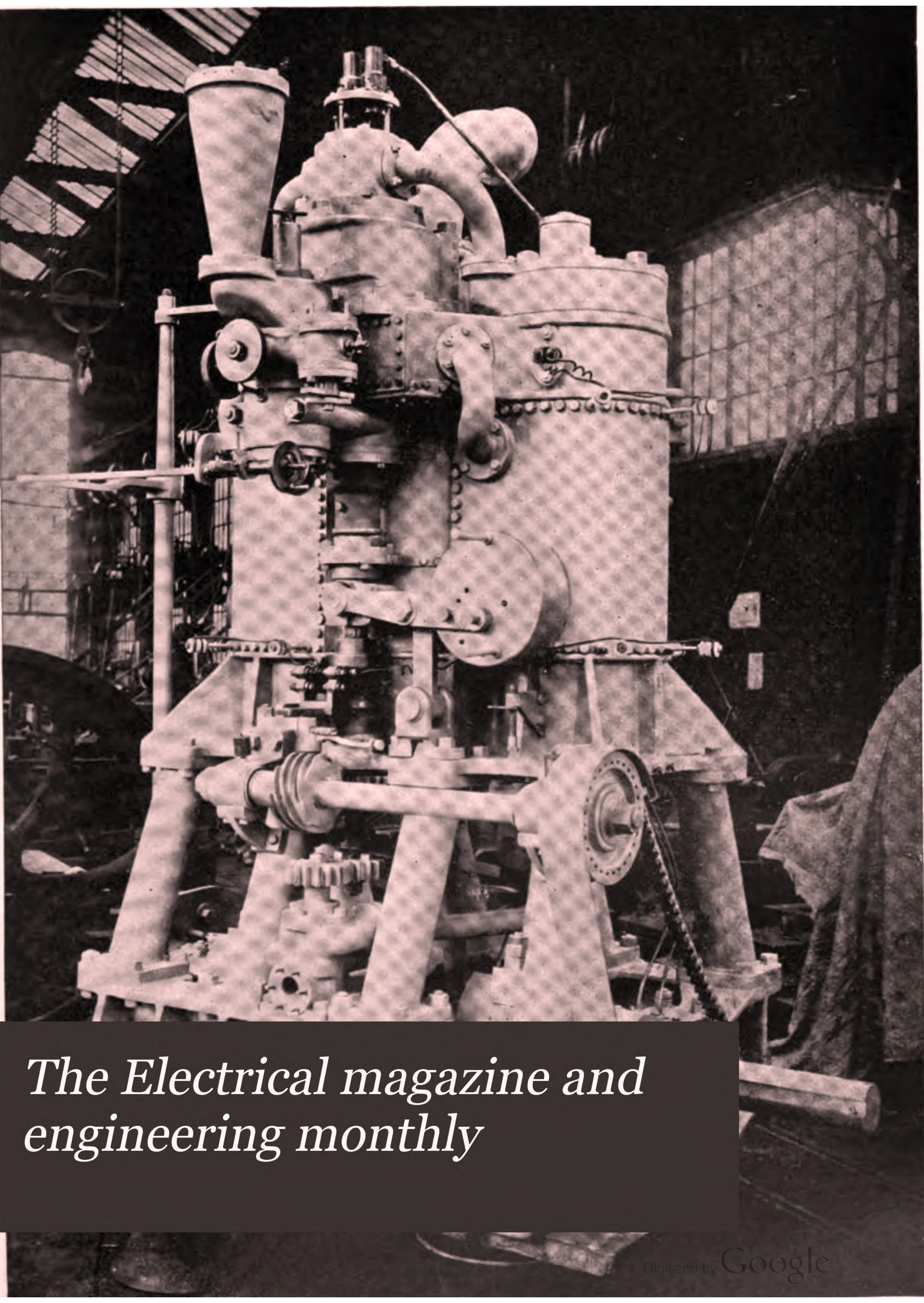

The Electrical magazine and engineering monthly

Alfred Hay.

The Electrical Magazine

EDITOR-IN-CHIEF:

THEO. FEILDEN.

ASSOCIATE EDITORS: LEADING AUTHORITIES IN EVERY BRANCH OF ELECTRICAL ACTIVITY.

ACTING EDITOR: W. E. WARRILOW, A.M.I.E.E.

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The

Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

Associate Editors: Leading Authorities in every branch of Electrical Activity.

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THE STATE OF THE ELECTRICAL INDUSTRY AND "THE ELECTRICAL MAGAZINE."

With this number we open our second volume, and present to our readers a complete index of the six preceding numbers. A glance at this index will bring home to the mind how completely and exhaustively this journal has carried out its programme and justified its second title, "an International Record of Electric Progress."

The material which has been handled to furnish our readers with the many articles and diverse information comprised in the first volume represents an enormous amount of matter obtained from every part of the world and a labour at headquarters which none but those who have personal experience of what is involved can adequately gauge. The brains of many men in the front rank of electrical science, industry, and development have been brought to bear upon it: we may say, in fact, that never has any technical journal before secured the services of such a body of talent and obtained the whole-hearted co-operation of so many distinguished contributors. In regard to the matter presented to our readers, the grain has been sifted from the chaff, and only that which we have considered of prime importance to those engaged in electrical work has been produced in our pages.

Mingled with pleasurable emotions at having achieved what is acknowledged on all sides to be a remarkable journalistic success, we cannot help heaving a sigh of relief at getting through what has been a most trying ordeal. The first year, but particularly the first six months, of the life of any journal which is seriously undertaken carries with it a weight of responsibility and work, one might almost say hard labour, which is not to be envied, but having got through what we believe will be the hardest and most trying six months of our existence, we look back with a certain amount of justifiable pride at the result, and note with gratification the increasing support which the Magazine is obtaining—support which spells progress all along the line.

We launched our first issue after having faced and overcome difficulties of no ordinary character. We had no apprehension as to the way it would be received, and our expectations were realised to the full—more than realised, in fact. It is no exaggeration to say that *The Electrical Magazine* has been accorded a spontaneous backing exceeding anything that has been hitherto secured by a technical periodical. It has been universally acknowledged in electrical circles the right thing at the right moment, and has justified in every way its claim to be a time-saver. The leading organs of public opinion through-

out the country and in many places abroad have eulogised its value in no unmistakable terms, and continue to do so, whilst the hundreds of letters we are continually receiving from all parts of the world present the strongest evidence of its practical utility. This striking manifestation has resulted in a genuine sale-circulation which, we believe, is already higher than that of any publication of its class, and the number of our regular readers is being gradually but surely added to month by month. The Magazine is, in fact, already recognised as an authoritative and indispensable compilation not only to the busy electrical engineer but to the man who desires to keep himself abreast of the times in regard to the application of electricity to his business or for any other purpose.

But, gratifying as has been the welcome given to our journal, we must acknowledge that never in our experience has there been a more disturbing period for doing business than that of the last few months. There appears to have been, and still is, a certain amount of reluctance on the part of many British firms to place orders, or to undertake any kind of enterprise, and money is evidently as tight as it can be, particularly at the present moment. This naturally affects the revenue of an engineering publication, but it is significant that during the existing trade depression *The Electrical Magazine* is not only holding its own but improving its position. There is no use whatever in disguising the truth that the electrical industry of Great Britain is just now in a very unsatisfactory condition. With a falling trade-barometer, this must necessarily be so; firms are unwilling or unable, under the circumstances, to electrify their works, and a considerable number of establishments are being carried on on old lines, with an obvious conservation of energy and funds until the money market is in a slacker condition and trade is better. We must go, however, a little further to account for the dearth of remunerative business which has existed for some time past among British electrical manufacturing houses. Foreign competition accounts for a large slice of it. We do not say that the whole of this competition is of an unfair character; a deal of it is, of course, and in many cases the producers of this country are totally unable to compete for reasons which are but too well known. It is a fact, however, that British electrical manufacturers are to a considerable extent themselves responsible for a heavy loss of trade which they might have secured. Great Britain has without doubt been too slow to adapt herself to modern requirements; she has simply been caught napping. The pushful and thorough Germans and the ever-wakeful Americans, to say nothing of other nationalities, have shown the lead in electrical development, and by their preparedness, capacity, and knowledge have been able to secure contracts which British firms were totally unfitted to handle. This, however, is being rapidly changed. English manufacturers have been putting their houses in order, the equipment of leading establishments with up-to-date plant has proceeded with a steadiness and perseverance which is in every way commendable, and to-day there are in Great Britain firms able and willing to undertake practically whatever demands may be made upon them.

There are other contributory causes to account for the present indifferent condition of trade in the electrical industry, but we do not at this moment propose to analyse them. We hold the belief that the wave of depression which is seriously affecting the industry will pass away in the comparatively near future—in fact, there are strong indications that the electrical business from about the end of this year and onwards will have an upward tendency, and that things generally will become more settled. The pendulum is gradually but surely swinging in the right direction. Let us hope that there will be work for all, for our people, and for foreign nations alike, and plenty of it.

The Editor of *The Electrical Magazine*, in company with members of the Institution of Electrical Engineers, will sail for the United States on August 26, and he will have many opportunities of watching and studying the progress of electrical development on his tour throughout America and Canada. Without doubt, this visit will have a considerable reflex benefit to the Magazine. Every factor which has contributed to American success will be carefully noted, and the remarkable

advance in electrical work which has taken place in Canada recently will be carefully considered and the results published in this Magazine for the benefit of its readers. The unique opportunities which the Editor will have on his travels should render the publication of his deductions and experiences of more than ordinary value.

We have only to add in launching the first number of our second volume that the spirit of progress and restless activity which has animated the management of this journal from the start will be carried forward with undiminished vigour and enterprise right through, and we have every confidence in saying that the thoroughness which we are pledged to, and have maintained, will receive the continued and largely increasing support of the important community we have the honour to represent.

THE I.M.E.A. ANNUAL CONVENTION.

THE ninth Annual Convention of the I.M.E.A. was an all round success, and reflects creditably on the Committee for the arrangements made for the many members and visitors who attend almost without fail each year. The papers were few and admitted of ample discussion, the excursions so admirably planned were the more welcome in the fine weather prevailing, and the attendance was well up to former years. The three chief meetings were held at Derby, Nottingham, and Sheffield, and though this plan is rather tedious from a travelling standpoint, monotony is avoided and the programme is necessarily more varied. Though ostensibly founded for the advancement of municipal interests the Association serves a wider purpose in admitting "company men" to its meetings and exchanging opinions with them. Mr. T. P. Wilmshurst in his Presidential Address prefaced his remarks with references to the growth of municipal electrical interests in this country. Within eight years the capital outlay controlled by Municipalities, has risen from four millions to twenty-five millions, and if the electric tramway concerns are included, o forty millions, a truly creditable record. The attitude of Parliament toward municipal electrical undertakings, was to be viewed with no little concern as continuity of policy was sadly lacking, an indictment backed up in the address by several examples, among which we may mention the inclusion of Bristol in a power companies area, the "famous or infamous Bermondsey clause," running powers and others. The Power Companies' incandescent lamps (too often allowed to burn beyond "scrapping point"), wiring, and lamp-testing were all considered in turn, while of motors, Mr. Wilmshurst, referring to his own case at Derby, could only speak of encouraging results. In five years his power consumers have increased from 20 to 250, and on a single-phase system at that. Tramway Committees comparing the charges made to them for current with those to private consumers are reminded that contrary to current opinion, a motor load has casually a higher load factor than a tramway load, and moreover required separate plants and mains. The assessment of electricity works is commended to the future notice of the Association seeing that this item varies from *.02d.* to *.7d.* per unit in various towns, and consequently needs considerable revision to relieve certain heavily burdened undertakings. An appeal to engineers to further the working of the Engineering Standards Committee concluded a very interesting address.

Of the papers read the palm must be given that by Mr. G. E. C. Shawfield, whose advocacy of electric traction by surface contacts was ably set forward, based as it was on an extensive yet trying experience at Wolverhampton. His arguments though lucidly put and backed by instructive figures were not convincing to his hearers, who on public and financial grounds spoke in favour of the overhead system. The discussion was varied, not to say humorous in places, and provoked a smart reply from Mr. Shawfield, who stood his ground well. Mr. A. J. Cridge whose

paper dealt with the meter department of a central station, gave the association his views on the subject chiefly from his Sheffield experience, and the discussion turned more on meter types than on the paper itself. It is only in very large stations where a regular meter staff seems necessary, seeing that several engineers controlling smaller plants than that at Sheffield, questioned the need for an apparently large staff set apart for this work. Mr. S. L. Pearce's paper read and discussed at Nottingham was also a valuable contribution to the series, and though presenting no very novel feature, as an assembly of types of substation plant, and figures relating to the operation of the same, it should prove handy for reference for some time to come. The discussion turned on the best frequency to be adopted and the merits of synchronous, asynchronous motors and rotary conververters. Mr. Ferranti, when called upon for remark, rather took electrical men to task for the complicated state of affairs existing in the interposition of so much machinery between the power-house and the consumer. His old advocacy of single-phase working again came to the fore and took the shape of an earnest appeal to simplify wherever possible, so that the reputation of the industry might be kept up against the severe competition of gas. He emphasised the simplicity with which gas was supplied, and pointed to the possibilities of single-phase generation combined with a static converter (such as the Cooper Hewitt), for producing continuous currents should these be required. His opinion was, however, strongly in favour of one-phase traction systems now made possible by improvements in motors, and their controlling devices. Although not strictly bearing on the subject of the paper, Mr. Ferranti's remarks are worthy of record as sounding a warning note to electrical engineers, who, at one time, willing to follow the guidance of early workers in the field, are now apt to be led aside from the aims and object of electricity supply,—simplicity in working. We hope yet to see developments sweeping aside the multitudinous auxiliaries now apparently inseparable from our large undertakings, and some system adopted more in keeping with the doctrines of pioneer electrical men in this country.

Mr. Faraday Proctor, in a paper on the Bristol Fire (see *Elec. Mag.*, vol. I., No. 2, p. 201), endeavoured to procure the opinions of engineers as to its cause, but in this he was not altogether successful as the speakers differed as to whether the fuse or a fault in the cable were responsible, Mr. Proctor meanwhile laying the blame on insulator leakage due either to moisture or a crack. Mr. R. Downe in a paper on Boiler House Economies, dwelt chiefly on the subject of combustion, and recommended the intelligent analysis of fuel and flue gases to further this as much as possible. The discussion evoked some rather scathing comments on stokers in general, and mechanical stokers in particular, but the speakers mostly dwelt upon their special point rather than the questions raised in the paper. Mr. J. R. Blakeway, chairman of Southampton Electricity committee, wound up the papers with a dissertation on the Financial Position of Electricity Supply Undertakings. In this he concluded that electricity as sold for power traction and public lighting was too cheap and only sold at the expense of the private consumer. His audience did not fall in with his views, however, and he fell back on the hope of convincing them of what he really meant in a reply to the *Journal*. These last two papers were discussed at Sheffield. The excursions arranged for, included visits from Derby to Chatsworth and Haddon Hall, at Nottingham inspection of stations and car-sheds, and a visit to the Brush Works, and at Sheffield, visits to the Tramway Power House, the New Neepsend Station, equipped with steam turbines, and the Hadfields company's works at Tinsley, where by far the largest party assembled. The electric driving of the works from a 2100-h.p. station, excited much comment. The Annual Dinner was held at Nottingham, on the day preceding the Sheffield round, and on July 1, the Convention closed with the Annual Meeting, at which Mr. F. A. Newington, Edinburgh, was voted to the Presidential Chair. Next year's meeting will therefore be held in Edinburgh, where doubtless an equally representative gathering will assemble.

The World's ELECTRIC PROGRESS

Editorial · Commentary of · the · Month.

Poulsen's Telegraphone.

In the Telephone Section this month we give some illustrated particulars of the latest form of the Telegraphone, an instrument to which we made reference last month. Apart from its value as a correspondence medium, when operated by clockwork, its extreme simplicity when electrically driven should commend it in a commercial capacity for dispensing with the services of a shorthand writer. The typist is still required, but need not be of necessity a stenographer, though the commercial schools of to-day usually combine both faculties in one. In any case a machine acoustically and mechanically superior to the phonograph, with additional advantages not possessed by that instrument, should claim a wide sphere of utility among authors, solicitors, teachers of foreign languages, &c. Coupled in circuit with the telephone, the instrument is an infallible witness to all orders given, and when so used in naval or military work can be turned to at all times for confirmation of the commands issued. We understand that when the electrical type is run off an ordinary electric light circuit continuously for about five hours, the cost is one penny.

Power in Bulk.

An instance in which a municipality has, on the advice of its consultant, decided to purchase power in bulk from a supply company is afforded in the Mirfield (Yorks) Urban District Council. After carefully weighing the costs of an independent station and the purchase of power outside, Mr. A. B. Mountain, of Huddersfield, the Council's Consulting Engineer, despite his erstwhile championship of small plants, recommended that current be obtained from the Yorkshire Electric Power Co. The agreement would seem to establish a somewhat novel precedent in that the Council undertakes the lighting of its area only, leaving the company to look after the numerous power-users and deal directly with them. The Council have evidently had the initial expenditure in view in adopting this course, as they will certainly save considerably in taking up lighting only at the outset, and stand to make profits earlier tnan if power-consumers were also taken up. Unlike the power company, which has a load factor to consider, they can perhaps afford to adopt this course, while the company will also benefit in obtaining a good all-day load. We understand that current transformed from the transmission voltage of 10,000 at a sub-station will be available next December. We shall doubtless hear of other Councils in the West Riding who will have the same problem to consider, following Mirfield's example.

The New York Central Locomotives.

All electric railway engineers will be interested in the unique type of locomotive which the New York Central and Hudson River Railroad Company has recently had constructed to the designs of its Special Commission. The locomotives will take the place of steam locomotives at present operating between New York and Croton and North White Plains, distances of 34 miles and 24 miles respectively. In the Traction and Transport Section this month we give some illustrated particulars of these interesting locomotives. The choice of direct current need excite little comment, but the use of gearless motors is a striking departure from current practice in heavy electric traction. The City and South London Tube line has, it is true, had locomotives of this type in operation for

several years, but it has remained an isolated instance of the use of electric railway gearless locomotives. For speeds up to 75 miles an hour, such as are contemplated on the New York line, it is readily conceivable that gearing would ultimately prove troublesome and costly to maintain, though there are many lines operating with geared motors. The Commission appointed by the Railway Company, however, among which are such prominent electrical men as B. J. Arnold and F. J. Sprague, has done its work well, and left no stone unturned to provide the Company with a thoroughly modern equipment, irrespective of everyday electric railway practice. Judging by the design of the locomotives in question, its efforts have been attended with singular success.

British-Canadian Trade.

As the chief commercial rival of Great Britain in Canada, the United States has a great advantage from the geographical standpoint, but this has been neutralised to a considerable extent by the preferential treatment accorded to Great Britain. One reason in the past for the increase of American exports to Canada is said to be that the American is a very enterprising business man, and offers Canadian buyers every possible advantage. For example, he usually makes goods in advance and supplies them from stock; while, on the other hand, the British manufacturer generally makes what is required after orders have been received, and Canadian customers have to wait their turn for delivery. Again, the American quotes for goods in the currency of the country and includes freight, so that the Canadian is able to tell the exact cost, which is impossible in the case of British goods for which quotations are made in the ordinary manner. Further, the American is always willing to create new patterns or types of goods, whereas the British maker is unwilling to consider innovations of the kind, or, if willing, he invariably demands higher prices. Many other circumstances of similar character might be mentioned, but we have said enough to make clear the point that British manufacturers must be far more accommodating than they are at present, if commercial relations with the Dominion are to be improved to any considerable extent. Canada has already given preference to this country, and although she cannot well make the preference greater, her tariff wall may be raised higher against other countries. Canada is quite able to do more against the United States, but is not likely to make any movement in such a direction unless better treatment is accorded to her by Great Britain.

On Telephones in General.

He would be bold, indeed, who would prophesy the early abandonment of the manual exchange for its automatic rival. Still there are distinct signs that some such result must be the ultimate end and object of automatic systems. In our Telephone Section this month a striking contrast is presented in the descriptions published there of a modern automatic telephone system and a manual exchange, whose existence so far can be counted in weeks. In comparing the two the claims for the machine system, the invention of Mr. G. W. Lorimer, stand out prominently, while, in contradistinction, the presence of the human element in the central battery exchange indicates the chief weakness in an otherwise accurate though elaborate scheme. The recent strike of operators at Holborn—amicably settled, we are pleased to note—emphasises the weakness referred to, seeing that such occurrences may disorganise the entire traffic, despite precautions taken by the management. Like many other systems in electrical engineering, design has been subservient to precedent, and progress has accordingly been only possible to a certain point. Beyond that the work must be continued by improved methods, founded on some higher principle, which can further the forward movement by another stage. The telephone exchanges designed for manual operation, in resting on this apparently broken reed, are subject to ultimate supersession by the automatic exchange, against which many objections may be raised except that of sole reliance on humanity for continued service. The automatic exchange presents such ideal operating conditions that its claims are

apt to be discredited. The monotony of the manual must not be overlooked, nor can it be said that the work is without drawbacks—frequently of a physical nature. If automatic systems can dispense with all this efficiently and with reliability they commend themselves for general adoption; but what company could fail to instal a scheme reducing its capital and operating expenditure considerably below present figures?

Telegraphs in British West Africa. WE confess to feeling disappointed that Government does not take up more vigorously the extension of railways and telegraphs in our possessions and protectorates in West Africa. The total value of imports and exports in 1901, as quoted in official returns, of Gambia, Sierra Leone, the Gold Coast, Lagos, and Nigeria, combined, was under seven million sterling, and this sum might be vastly increased if means of communication with the interior were improved. Including the possessions of France and Germany, and the Liberian republic, there is a tract of country some 2 000 by 700 miles awaiting a development which will bring a rich reward, and one in which our home manufacturers ought to play an important part. So far, short railway lines exist from Sierra Leone to Bo, on the Gold Coast from Sekundi to Obvassi, and from Lagos to Ibadun and Aro to Abeokuta. The High Commissioner in Northern Nigeria has recently applied for more railways in connection with the cotton cultivation that will profitably be carried on there. We trust that his representations will be well considered. The telegraphs have progressed a little further than the railroads. There must now be over seven hundred miles of telegraph in the Gold Coast, a thousand miles of line in Northern Nigeria, and a couple of hundred in Southern Nigeria, recently constructed. Lagos is connected with Jebba and Lokoja, and no doubt in the near future the important towns of Kano and Sokoto in the north will be joined by wire with the coast. There is no doubt that the telegraph is a stimulant to trade, but it cannot by itself promote trade where the means for carrying produce are not easy. Lady Lugard, in a paper on Northern Nigeria read at the Society of Arts last session, pointed out that a large part of the male population was occupied constantly in walking about the Protectorate carrying headloads of goods. This slow, laborious and wasteful method of transit is the relic of a primitive and barbarous age, and will, we hope, be superseded by the iron horse. At present, for administrative purposes the telegraph must be a convenience and an economy, and, wherever it goes, we may be sure that our grip upon the country will be rendered more secure and enduring. Could the reports of the telegraph construction officers be made public, and were they descriptive of the difficulties, anxieties, and dangers met with in the prosecution of their schemes, we should have many a romantic story and striking picture of life in African forests, swamps, and rivers, but busy men have little inclination to write after a day's work in the tropics, and much that is interesting is left unrecorded. We trust that our Government and our manufacturers will not lose sight of the possibilities of this portion of our Empire.

Exhibitions. AT the end of the Manufacturers' Section this month will be found illustrated accounts of the electrical features of the Bradford Exhibition, open until October, and the Colliery Exhibition, recently closed, at the Agricultural Hall. The first of these may tend to raise the hopes of electrical men, of breaking down the faith at present reposed in steam and of successfully applying electric power in the textile manufacturing trade. In conjunction with our remarks on this exhibition, Mr. J. Garcin's article on Electricity in Spinning and Weaving appearing in the Power Section should be read, as a direct comparison is therein afforded of the relative efficiencies of steam and electric driving. These have been in no way exaggerated, and do not take into account such items as fire risk, improved working conditions, flexibility, advantages of constant speed, and other items incalculable in a mere economy reckoning. If textile manufacturers will keep themselves posted on these matters they will be the more ready to embrace

the offers of the power companies so soon to be operating in their midst. It must be remembered that a great percentage of the new mills arising abroad are all electrically driven; and even assuming that cotton can only be successfully spun in Lancashire, the advantages of modern driving may tend to discountenance this circumstance.

The Colliery Exhibition can certainly be voted a success from the electrical engineer's standpoint. It cannot, of course, be compared with the mining exhibits of Dusseldorf, but it will serve to answer carping critics of our home methods of adopting improved appliances. The electric drills, coal-cutters, pumps, and hauling gears are now too familiar to need forcing on the notice of colliery men. They have found their "niche," and are filling it well. The mine manager will have been most interested in the winding-engine problem, and the proposals of electrical men to tackle it. At one time, the most sceptical ideas were entertained of electric winding-engines, their design, cost, and maintenance; but good work in this quarter has done much to change such views. To light the workings and drive the small machinery employed below and above ground were once regarded as the special and only functions of electricity, but to drive the winding-engine, no, indeed! Since then the steam-engine has been compared, and unfavourably, with the electric motor for traction work, the acceleration of the latter being vastly superior. Such comparison is valuable to colliery men, as diagnosing their case of steam *v.* electric winding-engines. We shall, at any rate, hope to see at the next Exhibition, to be held in 1906, that the experience of continental engineers in this particular has borne good fruit in this country.

Electricity in Agriculture.

THE recent Show held under the auspices of the Royal Agricultural Society at Park Royal was representative of what is being done to introduce machinery into every phase of farm life. In this respect the development of the crude oil engine is remarkable, and as a prime mover for isolated districts, where coal cannot readily be procured, it must shortly quite disqualify the steam-engine. A good mechanic, frequently a trained labourer, can attend to such an engine, and, now that makers are so accommodating in their designs, can effect quite considerable repairs without assistance. As to oil consumption, the best that can now be done is one half-pint per horse-power hour for large engines, an economy which if placed beside its many other advantages gives the oil engine a marked ascendency over steam. We refer now to its special suitability for driving dynamos for lighting and power. It is in this sphere that there is a big future for the oil-engine, and if properly taken up there should be prospects of its use for generating electric power as opposed to mechanical power for driving agricultural implements. While on the continent companies distributing electrical energy over wide farm areas are in successful operation, in this country we are content to make isolated experiments with power-driven appliances, adopting such only after long delay and indecision. The soil of this country, which for centuries proved a support to its people, has been allowed to decay because we have permitted other lands to employ labour-saving devices for tilling, reaping, &c., the while we bemoaned our declining agriculture and bad climate, content to depend on outside sources for our supply. Even assuming that statisticians are correct in asserting that when fully cultivated these islands would fail to support their present population, some effort might be made to revive a means of support which now would vanish in case of severance of present supplies. What other countries can do to develop the land by mechanical aid, we also can surely accomplish by a vigorous application of electricity to agriculture. Here is a problem for some wealthy landowner who would raise the standard of his estates and increase their yield "an hundred fold." Should Providence have placed a coal mine beneath his feet he may run a gas-driven power-house on economical lines and furnish his farmers with high voltage power for lighting their homes and doing work now laboriously performed by horses or by hand. In

addition, what possibilities are there not of assisting nature beneath the soil, or by the action of light in maintaining a constant supply of fruit, flower, and vegetable now only known in their season? Failing such a philanthropist, the farmers must avail themselves of the oil-engine and each operate his own plant according to needs. So much has been done by electricity for other industries, that its extension to agriculture would be welcomed especially in a country like our own, where the decay of the "labourer" is so much bemoaned. In the prevalent cry of "back to the land" we shall listen for a note heralding the aid of electricity in the revival on some higher plane of the life agricultural.

Canadian Electrical Progress.

THE Annual Convention of the Canadian Electrical Association was held, from June 15 to 17, in Hamilton, Ontario, and was a great success. A number of interesting papers was as usual, read, among which we may refer especially to one on "Heavy Electric Traction," by P. M. Lincoln, whose opinions always command respect, and another from Mr. G. Johnson, the Dominion statistician, whose "Statistics of Canadian Electrical Progress" contain some instructive figures. In electric railways Canada is well advanced, there being, according to the returns to December 1903, 46 in operation with 650 miles of track, single and double, and 2341 cars and trailers. The miles run amount to nearly 40 million, and over 167 million passengers were carried, while the employees number 7440. These figures are from companies making official returns, these now totalling forty-six as compared with thirty-five in 1898. The accident particulars make interesting reading; in 1902 the total reached 563 from all causes, but in 1903 the numbers had increased to 778, of which no less than 320 were due to jumping off the trains. Collisions were responsible for 84, contact with moving cars 159, falling off trains 89, and walking on the track for 76. Telephone figures are also a valuable record of progress, seeing that the first commercial experiments were made in Brantford, and the earliest instruments used in Hamilton. In 1893 there were 44,000 miles of wire, 33,500 instruments, and 72½ million messages sent; in 1903 the instruments were increased to 81,500, and the messages to nearly 254 millions—a difference of 144 and 250 per cent. respectively. Taking the Canadian population of the last census, there is one telephone to every 65 persons, a truly creditable performance. None the less creditable is the progress in electric lighting and power. Our readers have already become familiar, through our Power Section, with the Montreal Power Scheme, and as this can be taken as typical of Canadian development little effort will be needed to grasp the power possibilities of the country. There are 316 plants in the Dominion, compared with 80 in 1891, and of these Ontario can claim 199, Quebec being a bad second with 49. Of the Ontario plants 100 used steam, 60 water, and 35 water and steam, the remainder sending no returns. In contradistinction, 38 plants in Quebec are water-driven, the rest being steam-and-water operated. In electric lighting, also, we find that there are now 324 plants, with 14,780 arcs and 1,212,861 incandescents, or a total of 1,360,661, taking one arc as equal to ten incandescents, on June 30, 1903, representing an increase of 21 per cent. in twelve months. Here again Ontario scores over other provinces, having 203 of the total plants laid down, one-half the arc lights, and forty-seven in each hundred incandescents. British Columbia shows the largest proportionate increase, this being 82 per cent. for arcs, and 257 per cent. for incandescents. Mr. Johnson is sanguine in concluding his paper. "Electricity will drive the carriages on the King's highway as well as those on the iron way. It will do our ploughing, our sowing, and our reaping." In a country like Canada, such utterances more truly herald the results of progress than they could in this country. For electricity, Canada presents boundless possibilities, so much so that in future we may refer to her, not as "The Lady of the Snows," but as the "Lady Electra."

Concerning Main Line Electrification.

A STEADY stream of opinion on the subject of main line electric traction continues to proceed from the technical electrical Press, and the most recent contributions to current thought on this important topic have appeared in our contemporary, *The Light Railway and Tramway Journal*, whose world number made a special feature of the various aspects of electric traction. Mr. Philip Dawson, drawing attention to the necessity for electric traction and the advantages secured by its use, comes to some interesting conclusions regarding the equipment of track and rolling-stock. He condemns wholesale the third or fourth rail methods for collecting current, recommending the overhead conductor as the only practicable system, and one which brings him at once to the advocacy of the one-phase system. Almost in the same breath he concludes that any system installed for local or suburban traffic should be capable of extension to main lines when necessary. This clenches his arguments against the third rail, and in favour of one-phase operation. Mr. Dawson sets out some new conditions of working for an ideal railway traction system, all of which, though difficult to fill, are met by the one-phase system. Referring to the heavy capital expenditure of electrification, he suggests that this *bête noir* of the railway companies be removed or palliated by Government encouragement. He says, "as railway companies cannot at present be compelled to increase their train service they should be helped both out of the rates of the places they tend to develop"—(by distribution of population)—"and by the Government. Such help might take the shape of a bonus per passenger carried or a guarantee for a certain number of years." It is doubtful how the Government or the town so much indebted to the railway companies would receive such a proposal, though it has considerable bearing on the subject in question. Mr. Dawson rightly condemns any probable action of railway companies in "sandwiching a few isolated electric trains" between the local steam service, as perverting the objects and possibilities of electrification.

Mr. J. W. Jacomb Hood, in the same journal, makes out an unvarnished case for the railway companies. After some pointed references to the want of agreement among electricians on the best system to be adopted, and the influence of this on railway men, Mr. Hood pours cold facts on the zeal of enterprising electrical engineers. We are told there are 22,200 miles of railway territory occupied in the United Kingdom, the railways for which have cost 1217 millions, construction and equipment. Of locomotives there are 22,805, costing 45 millions, and rolling-stock comprising 52,000 cars or another 10 millions. Mr. Hood then inquires as to the expenditure needed for electrification, taking as his guide, and, as he says, the only guide of railway men, Mr. W. E. Langdon's figures, based on a three-phase direct-current system with rotary converters. With a third rail, this is to cost £10,000 a mile, or 220 millions for the whole railway system of these islands. Such figures cannot now be reasonably regarded as even approximate, for one-phase working will dispense with low-tension leads, substations, and transforming apparatus outside the trains. The capital outlay would still be high, but in making comparisons, more recent data, of which there is sufficient for guidance, should be drawn upon. Mr. Hood signifies the attitude of railway men as that of patient waiting, the while electricians have perfected their plans, though at the same time he considers that marked social changes will force upon them some method of electrical operation, if only on a part of their system. A good case is made out for suburban working by "Scrutator," who also writes to our contemporary under the title "Is Electric Traction the Remedy? The Mersey Railway Evidence." Out of a quantity of valuable figures he makes good the case for suburban electric traction, the bare working cost of the Mersey line showing a saving of 23.0 pence per train mile over steam operation. On the total costs the showing is not so favourable, but the line has made real progress since its conversion, having gone far towards doubling its passengers while giving a vastly improved service.

SPECIAL ARTICLES

NOTES ON THE STARTING OF POLYPHASE INDUCTION MOTORS.

By W. BUECHI.

THE following notes relative to the starting performance of polyphase induction motors, and regarding the construction of such motors as far as the starting arrangements are concerned, may perhaps prove useful to those interested in this class of machinery. Polyphase induction motors may be divided into three classes, depending upon the arrangement of the rotor winding, and the method of starting, namely, motors with permanently short-circuited rotors, motors with wound rotors and rotating starting resistances, and motors with wound rotors and slip-rings. Motors of the first class are usually arranged with so-called "squirrel cage" rotors, in which the winding of the rotor consists of copper bars short-circuited at the ends of the rotor core, by means of rings of copper or other metal; variations in this construction consist in suppressing the rings, and short-circuiting the rotor-winding in sections by end-connectors, or, in short-circuiting the rotor-bars with the help of radial connectors terminating in a gun-metal hub, carried on the shaft. The motors of the second class do not require slip-rings, the internal resistance being short-circuited by external means after the motor has reached full speed. Motors of the third class start with the help of an external rotor resistance, which is gradually diminished as the motor runs up to speed; with this class of motor the rings are frequently arranged to be short-circuited, and the brushes lifted off them after full speed has been attained.

The great advantages of the first class of motor lie in its inherent simplicity of construction, and in its simple operation; no starting-gear is required, and on account of this, and also because the construction of the motor itself is of the simplest possible character, there is little to get out of order, and the first cost of the machine is reduced to a minimum. The great disadvantage of the type is, that even when starting against quite a small torque the starting current taken by the motor, compared with the full load running current, is abnormally large.

If the motor is of any size, this heavy starting current (which has a very low power factor) may produce serious fluctuations of pressure upon the supply system from which it is operated, the extent of these fluctuations depending principally upon the size of the generators and transformers supplying the system, and upon their quality from the pressure regulation point of view; it is for this reason that most lighting companies employing a polyphase distribution insist that the use of this class of motor shall be limited to the smallest sizes.

In spite of the heavy starting current taken by motors with permanently short-circuited rotors the starting torque that can be exerted by them is small, and it may

even occur (especially with two-phase motors) that a comparatively small increase in the resistance offered by the load to the motor at starting is sufficient to prevent it running up to speed at all; on the other hand, the position of the rotor in respect to the stator frequently affects the starting qualities of the motor, especially when the motor is called upon to exert an abnormal effort at starting. Thus, with this class of motor, quite apart from its effect on the supply system, it may happen that the currents in the stator and rotor attain such heavy values during the starting period as to cause serious heating, which, in spite of the robust construction of the motor, may cause it to deteriorate, and even to break down. For these reasons, as a matter of general practice, it is usual to employ this class of motor only when the starting torques required are inconsiderable, and well under control, and even under these conditions, to limit the size to about 6 b.h.p.; generally speaking, under these conditions, no serious fluctuations in pressure would occur on a well laid-out supply system for lighting and power.

In motors of this class designed by the writer, a special (patented) winding is used, which during the period of starting (when the winding is comparatively cool) has a considerable resistance, this latter steadily decreasing as the temperature increases. Thus, during the starting period the starting torque is increased, and the stator current reduced, while, after the motor has run up to speed and the load thrown on, the resistance of its rotor windings attains its minimum value after a short time, and the motor operates under the proper conditions with regard to efficiency. In these special rotors there are no soldered joints, and they can be operated continuously at temperatures even as high as 100° centigrade.

Although the disadvantages given above apply to all motors having permanently short-circuited rotors, irrespective of size, they become very much more marked with motors over 6 b.h.p. in size. The starting current, increasing with the horse-power of the motor, has greater and greater effects on the supply system, and further, owing to the small starting torque, it is necessary to use special arrangements for starting, either using fast and loose pulleys on the main-shafts, or suitable clutches in lifting and hauling work; further, in motor generator sets, it is necessary to start always from the generator side. These arrangements complicate the installation and render it more costly, so that, although the motor itself is exceedingly simple, this advantage is outweighed by the disadvantages. In spite of this there are still some makers who construct and put in motors with short-circuited rotors for quite large powers, either because the system on which they are run is used for power-distribution only, or because the conditions are specially suitable for starting light, or, finally, because the client has not made himself fully conversant with the properties of these motors.

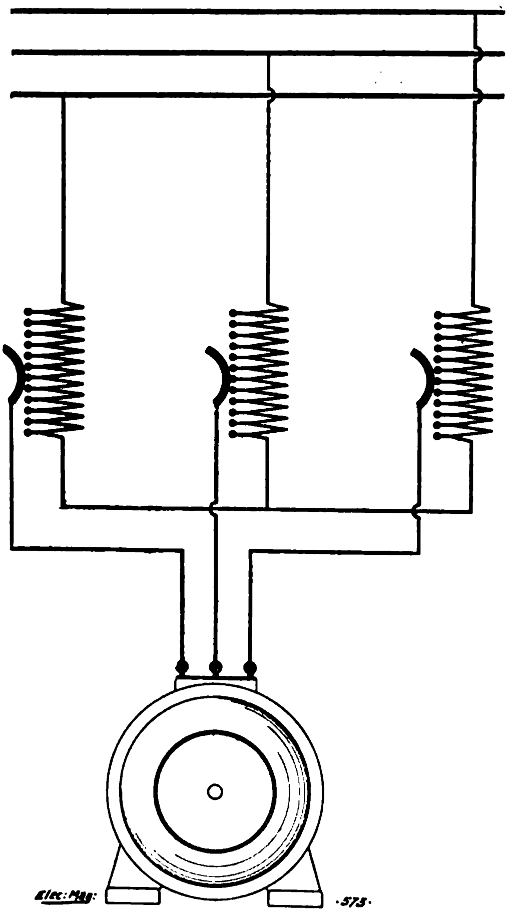


FIG. 1.

Diagram of three-phase motor, starting with variable ratio compensator.

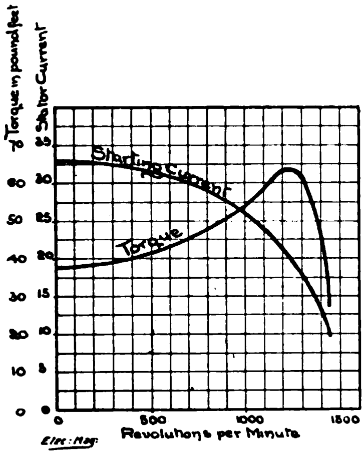


FIG. 2a.

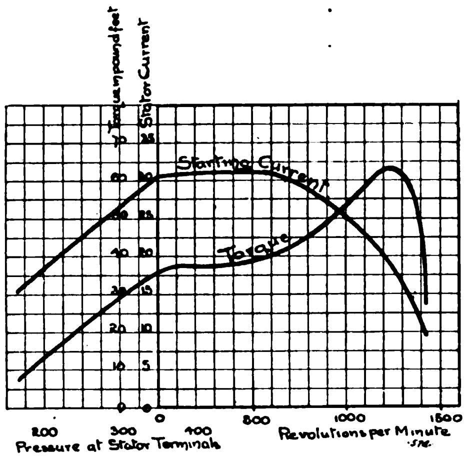


FIG. 2b.

Curves of starting performance of motor with short-circuited rotor, with or without compensator.

In order that the necessary starting current may not be taken directly from the supply system, motors with permanently short-circuited rotors are often supplied with what is usually known as a compensator, placed in the stator circuit. This compensator is simply a transformer with a single winding, placed in the stator circuit as shown diagrammatically in Fig. 1; in this particular pattern of compensator, a number of tappings are taken out from the windings to a controller, enabling a graduated pressure to be obtained for starting purposes, but in the usual American pattern only one tapping from the winding is brought out and hence but one secondary pressure is available. By the use of such a compensator, it is possible with a given primary pressure to obtain a larger (secondary) current in the motor circuit at a correspondingly reduced pressure on the terminals of the motor. If the starting torque is small the compensator can very largely reduce the starting current taken from the supply system compared with that taken by the motor itself, during the starting period.

But, as will be seen later, this can only occur if the motor is starting practically light, that is, developing an exceedingly small starting torque. On the other hand, if at starting motors of this type are to give a torque approximately equal to the full load torque, the stator current required will be as much as two or three times the full load current, and for providing this large current a compensator is of little use. For with the normal pressure on the stator terminals and the motor at standstill (that is, the rotor being at rest), the stator current is about three times greater than the full load current, unless the stator windings consist of a comparatively small number of turns. The effect of the latter would be to considerably increase the saturation in the air-gap, and consequently to increase the no-load current and to diminish the efficiency of the motor. As a matter of fact, the ratio of the actual starting current under these circumstances to that drawn from the line will only be in accordance with the ratio of transformation of the compensator, when the secondary pressure of this latter is as much as two-thirds of the primary pressure; but in such a case the compensator is of little use, since at starting the current taken from the supply system is practically the same as that absorbed by the motor.

It follows, then, that the compensator can only be used to reduce the starting current when at the same time reducing the starting torque. In other words, a motor with short-circuited rotor, which must give its full load torque at starting, will take from the supply system a current which will be nearly the same whether a compensator is used or not.

The diagram in Fig. 2*a* gives the curves for current and starting torque for a motor with graduated compensator working as described above. Comparing this diagram with that of a motor of the

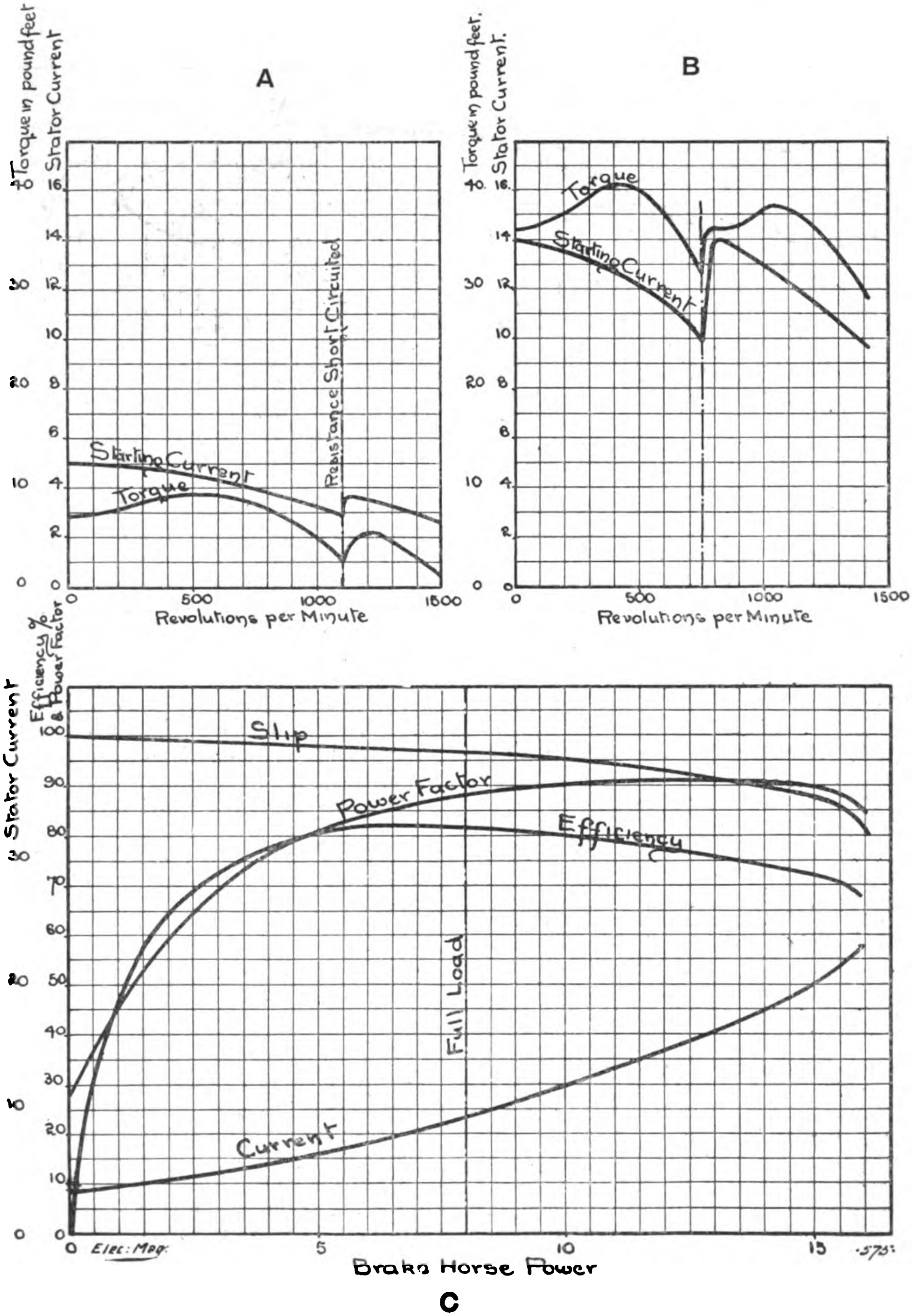


FIG. 3.

A *and* **B** (*top curves*). *Curves of starting of motor with internal resistance when starting against no load torque and full load torque.* **C** (*bottom curves*). *Curves of general performance of above motor.*

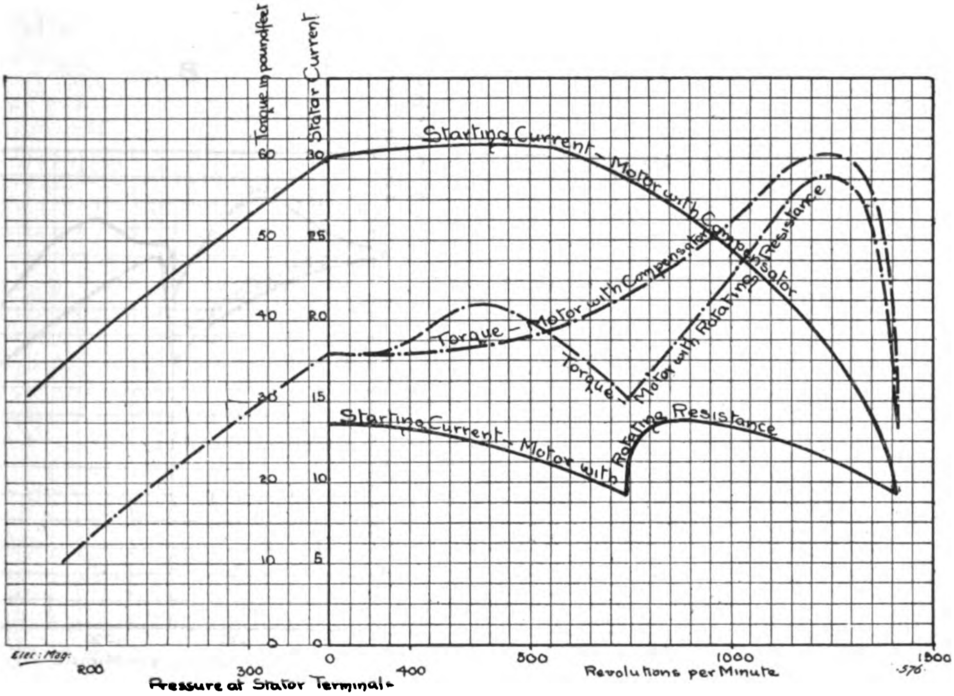


Fig. 4.

Curves comparing starting of motor with short-circuited rotor and compensator with that of motor with internal starting resistance.

same output without a compensator, shown in Fig. 2*b*, it will be seen that the disadvantage of the large starting current with only a comparatively small starting torque is practically the same for a motor with compensator or without. The only difference in the starting of the two motors is, that when a compensator of the pattern in question is used the current is gradually increased from a small value up to the maximum, whilst if a compensator is not used the full current is switched directly on to the line and the fluctuations thereby produced are more serious. But against this, one must remember that the starting of a motor with a graduated compensator is more complicated, and that the first cost of such a compensator is by no means small. Many makers have sought to get over this disadvantage by using a wound rotor with slip-rings, even for quite small outputs. The disadvantage of this is that the slip-ring motors have parts which are exposed to wear, such as the brushes and rings, and which require more or less attention. For large motors, this is not a serious disadvantage, but in the case of the small motors which are seldom or never inspected, it is of the utmost importance to keep the working parts as few and as simple as possible, in order to ensure satisfactory working.

The second class of motors mentioned above have a starting resistance which revolves with the rotor, and an apparatus for short-circuiting this either by hand or automatically in two or more steps; such internal starting resistances must be of thoroughly substantial design, both mechanically and electrically, and so arranged that the parts are easily accessible for inspection or repair.

Figs. 3A, 3B, and 3C clearly indicate the characteristic properties of such a motor, from the point of view of starting current, starting torque, efficiency, power factor, &c.; it will be seen very clearly from Figs. 3A and 3B that when starting in two steps in this way and for the same starting current, the starting torque either when starting light or against load is much greater than for a motor with short-circuited rotor.

From the curves of Fig. 3B it will be

FIG. 5.

Wound rotor with rotating resistance and short-circuiting device.

seen that the motor can develop a starting torque equal to the full load torque without taking more than one and a half times the full load current. This type of motor not only takes a starting current which is comparatively small when compared with the full load current, but it develops at starting a torque which allows the motor to be always started under full load.

Fig. 4 gives the starting curves for a motor with rotating resistance, compared with those for a motor with short-circuited rotor and compensator. From this it will be noticed that with two three-phase motors, each of 8 h.p. 500 volts, running at 1500 revolutions per minute on a 50 cycle circuit, the current absorbed by the motor with short-circuited rotor is more than double that taken by the motor with rotating resistance, whilst each are giving approximately the same torque at starting. The curve shows that the torque of the motor with short-circuited rotor increases with the speed up to a maximum which is about double the full load torque of the motor, and then rapidly diminishes as the speed approaches synchronism. On the contrary, the torque of the motor with rotating resistance increases rather more rapidly at first, then diminishes somewhat until the starting resistance is short-circuited, when it increases rapidly up to a maximum of about double the full load torque, and then rapidly diminishes. The currents taken by the two motors are shown on the figure. Comparing these, it is at once apparent that the motor with rotating resistance is far superior to the motor with short-circuited rotor and compensator. If the full load curves of these motors are compared from the point of view of power developed, and energy absorbed, it is evident that the motor with permanently short-circuited rotor (in which he rotor resistance is smaller), is slightly better than that with wound rotor. But this advantage does not compensate for the disadvantages at starting. The construction of the motors with rotating resistance is as substantial and simple as that of the motors with permanently short-circuited rotors, whilst no external starting-gear is required, and in consequence the working is simpler than for motors of the latter class when used with a compensator. Moreover, there are neither brushes nor slip-rings, and consequently there is no part exposed to wear.

At first sight it would appear that the winding of a rotor in several sections would be less solid and more likely to be damaged than that of a permanently short-circuited rotor. This, however, is not the case if the rotor conductors are soldered directly to one another without using end-windings. Fig. 5 shows such a rotor, and it will be seen from this that the winding is thoroughly solid, and quite as suitable for overloads as any permanently short-circuited rotor. The rotating resistance is mounted on a special hub, the connections being riveted together; it is amply large for the work it has to do, and is insulated in such a way that even if the temperature rises up to 100° C. no damage will be done. Fig. 6 shows one of these resistances dismounted; the resistance is attached to the end-frame of the rotor by three feet, and the connecting-strips are bolted to the ends of the rotor winding.

This method of fixing the resistance on the rotor allows it to be very readily dismounted and replaced by another, should this ever be necessary. In order to cut out the resistance from the circuit,

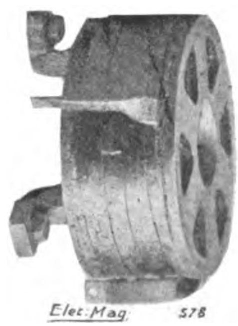


FIG. 6.

Internal starting resistance for three-phase rotor, showing method of fixing.

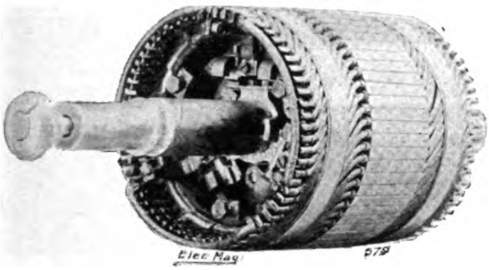


FIG. 7.
Wound rotor with rotating resistance removed to show arrangement of short-circuiting device.

and to short-circuit the rotor winding, a special arrangement is mounted on the shaft, operated by a rod passing through the centre of the shaft, and terminating in a knob at the outer end. The contact pieces on this short-circuiting arrangement are very heavy, so as to ensure thoroughly good contact. Further, they are so placed that, owing to centrifugal force, they are driven harder against the contact pieces fixed at the end of the winding, and indeed press so hard against these that it is almost impossible to draw out the short-circuiting arrangement while the rotor is running at full speed. This ensures that the short-circuited rotor has a minimum electrical resistance.

Nowadays if, as is sometimes the case, motors with short-circuited rotors are preferred to those with rotating resistances it can only be put down to faulty short-circuiting arrangements, and the bad contacts which naturally result therefrom. These considerably increase the rotor resistance and diminish the efficiency of the motor, and further, the contact blocks, if too small, frequently burn, producing a very bad contact afterwards. Naturally, the slip of the motor increases considerably in this case, and its overload capacity is diminished. The arrangement just described possesses none of these defects; like the resistances, the short-circuiting arrangement can readily be dismounted, and is easily accessible when the resistance itself has been drawn off. Fig. 7 shows a rotor with its rotating resistance dismounted, to render the short-circuiting gear easily visible.

The motors of the third class with slip-rings and exterior resistance must be used in all those cases where the regulations of the supply company state that the starting current shall not exceed the full-load current, or where the starting torque must be several times as great as the full-load torque, or, finally, if the motor is to work at a variable speed. It is usual to construct this class of motor (for powers of 4 h.p. and upwards) with three-phase rotors, arranged so that the starting torque is as constant as possible for every position of the rotor in respect to the stator, and so that there are no

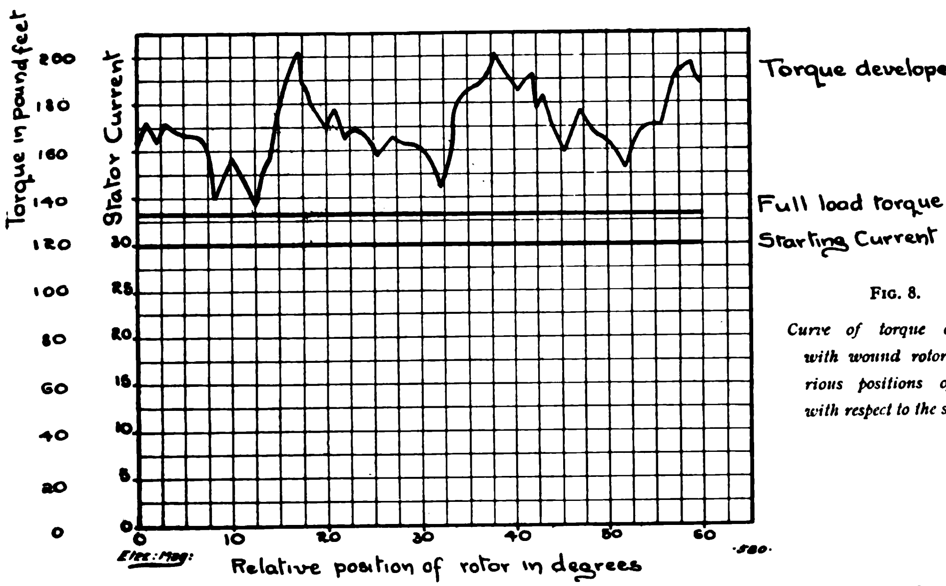


FIG. 8.

Curve of torque obtained with wound rotor in various positions of same with respect to the stator.

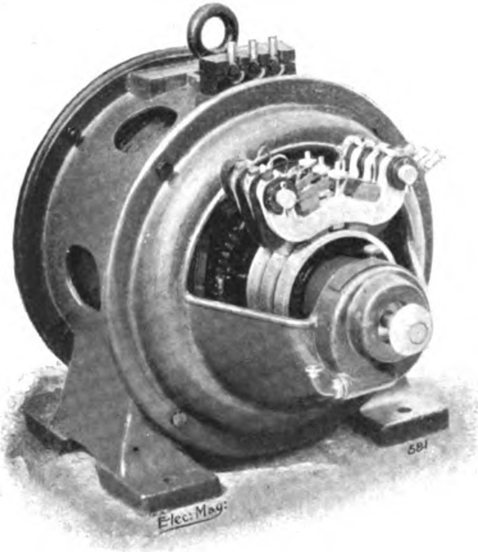


FIG. 9.
Three-phase motor with wound rotor and slip-rings, showing arrangement for short-circuiting the rings.

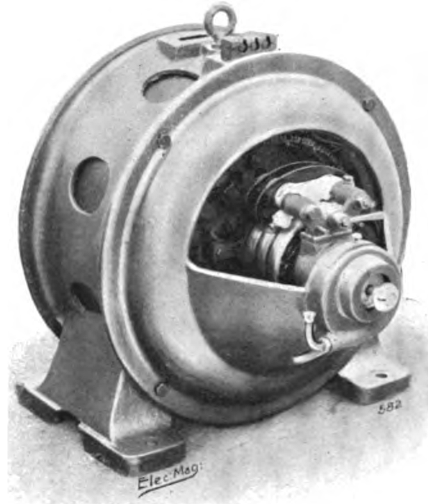


FIG. 10.
Three-phase motor with wound rotor and slip-rings, showing arrangement for short-circuiting rings and raising the (copper) brushes.

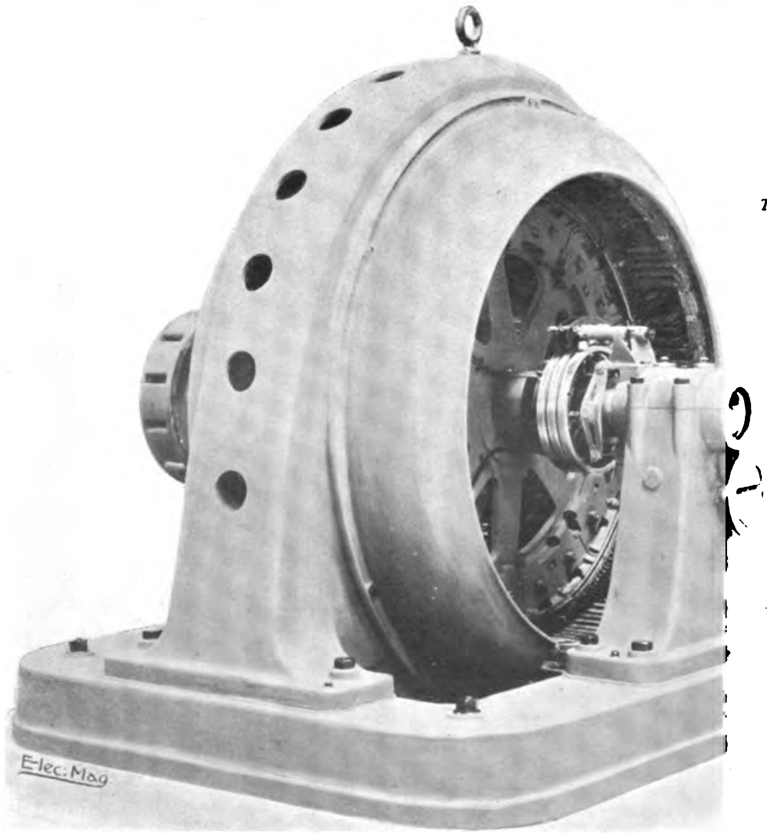


FIG. 13.
Three-phase motor, 300 b.h.p with wound rotor and slip-rings, showing arrangement for short-circuiting the rings and raising brushes on attainment of full speed.

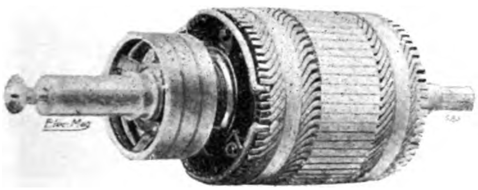


FIG. 12.

Wound rotor with slip-rings and short-circuiting arrangement.

positions of small torque, as is frequently the case for motors in which the number of slots in the stator per pole per phase is wrongly proportioned to the number in the rotor; in such a case, however, the use of resistances in series with the rotor windings very much improves matters, and the consequences of faulty design are not so serious as with short-circuited rotors.

Fig. 8 shows the torque of a modern 25 h.p. motor with starting resistance at different positions of the rotor with respect to the stator. The diagram shows that the minimum starting torque, when a current approximately equal to the full-load current is taken, is still larger than the full-load torque of the motor, this showing that the number of slots in the stator and rotor are thoroughly well proportioned.

In all motors designed by the writer the slip-rings are mounted within the bearing on a special spider, on which they are fixed so as to be thoroughly central and easily removable. The rings are of hard phosphor bronze of the best quality, and are compressed on the surface by a special process, so that the wear on them is reduced to a minimum. For motors with variable speed, carbon brushes are used (Fig. 9), for it is not possible to lift these. For all the other motors which are not frequently started and stopped, and which run without speed regulation, copper brushes are used (Fig. 10), and these are arranged to be lifted off the rings after the motor windings have been short-circuited. Fig. 11 shows a set of slip-rings which has been removed from the rotor, and Fig. 12 shows the complete rotor with rings.

FIG. 11.

Slip-rings for three-phase rotor, showing method of fixing.

All these motors are so arranged that up to sizes of 40 h.p. they can be used either with rotating resistance or with slip-rings, as required, the resistances and rings being fixed in exactly the same way, and being interchangeable. The winding of the rotor is exactly the same in the two cases.

For large motors it is usual to construct the short-circuiting arrangement in such a way that the windings are short-circuited and the brushes lifted off the rings by one single operation. Many makers have even adopted this arrangement for small motors, on the ground that it avoids any mistakes in starting. In point of fact, the likelihood of mistake is just the same in each case, for it will only occur owing to the position of the short-circuiting arrangement, and not of the brushes, and may just as likely take place in the one case as in the other.

Fig. 13 shows a 300-h.p. motor with slip-rings, in which the windings are short-circuited, and the brushes lifted by means of a hand-wheel shown on the outer bearing.

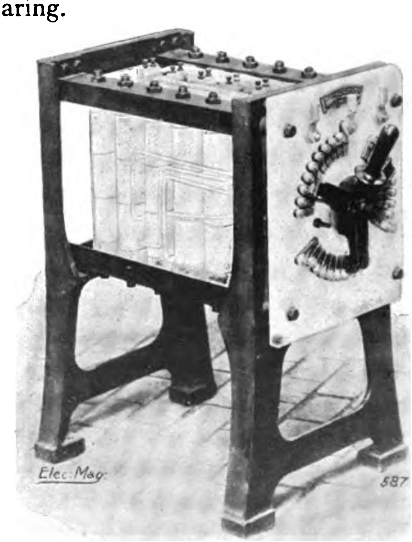


FIG. 14.

Starting resistance for three-phase motor.

The starting resistances constructed for the above slip-ring motors (Fig. 14) are wound entirely on porcelain cylinders carried in an iron framework, all connections being either riveted or bolted. No combustible material whatever is used in their construction and no soldered connections; it is, therefore, unlikely that the starters can be damaged, either by overloads or by mistakes at starting. Each resistance is supplied with a vertical marble panel, on which the contacts are mounted, these being arranged so that the resistance in each phase can be put in in ten steps; as a rule, the arrangement is such that on the first step the starting current is about 80 per cent. of the full-load current.

THE ADVANTAGES OF THE THREE-CYLINDER COMPOUND GAS-ENGINE FOR LARGE POWERS

By EDWARD BUTLER, M.I.Mech.E.

In the application of gas-driven engines to the generation of electric light or power, as much consideration is centred on the efficiency of an engine having a continuous turning effect as on economy of fuel and cost of plant. It is a generally accepted thesis for it to be considered the rule rather than the exception in gas-engines for evenness of torque to be not a strong point, and to be just where they usually show to least advantage in comparison with well-balanced multiple-expansion steam-engines.

In gas-engines of the ordinary four-phase type, if it is required to obtain two equally spaced impulses in one crank revolution it is necessary to have either two double-acting or four single-acting cylinders, either arranged as side-by-side two-crank engines or connected tandem fashion to one crank. A properly and evenly balanced engine of the four-phase type is better adapted for generator work than the two-phase type of engine, owing to the ability of the former for higher speed. Much consideration has been given to this question of correctly balancing the moving parts, and is responsible for the production of such types as the vertical three-crank single-acting Westinghouse engine; the Oechelhauser three-crank balanced piston engine; the Cockeril, Nuremberg, and Letombe four-cylinder single-acting two-crank engines; and, coupled in pairs with cranks at opposite angles, engines of the Deutz and Crossley *vis-à-vis* type and other engines with double-acting cylinders: all of which have been widely adopted for direct coupling to alternators of large size.

But, from the point of view of correct balance of the moving parts, combined with a regular turning action, the compound three-cylinder three-crank engine is the most perfect yet considered. In this engine, whether single- or double-acting cylinders are used, there is an even balance obtained from the reciprocal action of the three explosion and expansion pistons; the two explosion cylinders being arranged side by side of one centrally situated expansion cylinder, and the two explosion pistons, which are connected by two cranks at the same angle, being balanced by the expansion piston connected to a central crank at an opposite angle to these; the weight of this piston and rod is approximately equal to the combined weights of the two smaller pistons and rods. The three cranks being either independently balanced or partly compensated by an allowance made in the flywheels, when constructed with independent balancing of each crank, this type of engine approaches to almost

perfect equilibrium of all the moving parts and explosion effect, seeing that it obtains four equally spaced impulses during each cycle of two revolutions — an advantage which makes it possible for engines of this type to attain a higher speed of rotation with smooth and even action than any other.

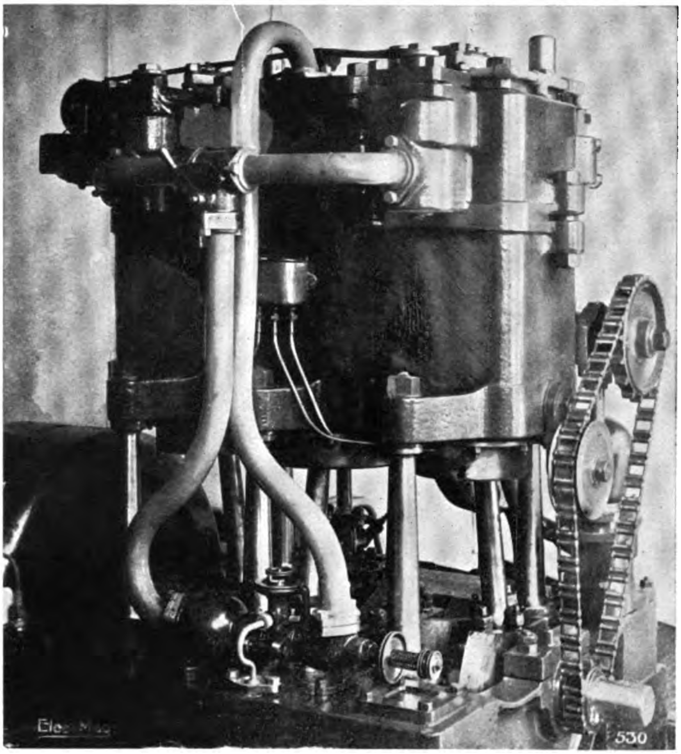


FIG. 1. HIGH-SPEED COMPOUND OIL-ENGINE.

In the writer's experience a compound oil-engine of this type (Fig. 1), having three cylinders 7″, 10″ and 7″ × 8″ stroke with balanced cranks, and weighing 16 cwt., was temporarily fixed down to the floor of a back-street City show-room without any foundation whatever, and access to the cellar beneath being inconvenient, no extra support was given to the floor, although the position of the engine was right in the centre of the room; this engine was run there for exhibition purposes, driving a twelve-unit dynamo at a speed of 400 revolutions per minute for six months, and in that time no complaint was made by the tenants overhead as to any inconvenience experienced from noise or vibration. This is conclusive proof of the extreme smoothness of the running, and demonstrates the practical advantage of an engine capable of being fixed down ready for use without it being necessary to provide a costly concrete foundation to be most considerable.

To emphasise the importance of having the impulses in an explosion engine equally spaced and at frequent intervals when used for electricity generating purposes, a comparison of the angular deviation obtained in engines of various types will be here interesting; disregarding for clearness' sake variations in the different speeds and the methods for equalising the rotating and reciprocating forces resulting from differences in cylinder and crank disposition, and assuming unity of deviation or turning effort efficiency to be represented by an ordinary four-phase engine with one single-acting cylinder, then the comparison for other four-phase engines will be as follows: for double-cylinder *vis-à-vis* or *dos-à-dos* single-crank engines and engines with one double-acting cylinder, the turning efficiency is only represented by two, as in each of these designs the explosion effects take place at unequal intervals; for double-cylinder engines arranged tandem fashion with one crank the value is found to be four, the explosion impulses in this case being at equal periods; for a three-cylinder three-crank single-acting engine the value is nine; for two double-acting or four single-acting engines, whether arranged tandem fashion with one crank or side by side with two cranks, the combined torque efficiency is equal to sixteen; this also represents the value for two-phase single-cylinder engines such as the Koerting and Voght; and for Oechelhauser engines coupled together in pairs. For the three-cylinder three-crank single-acting compound engine the torque

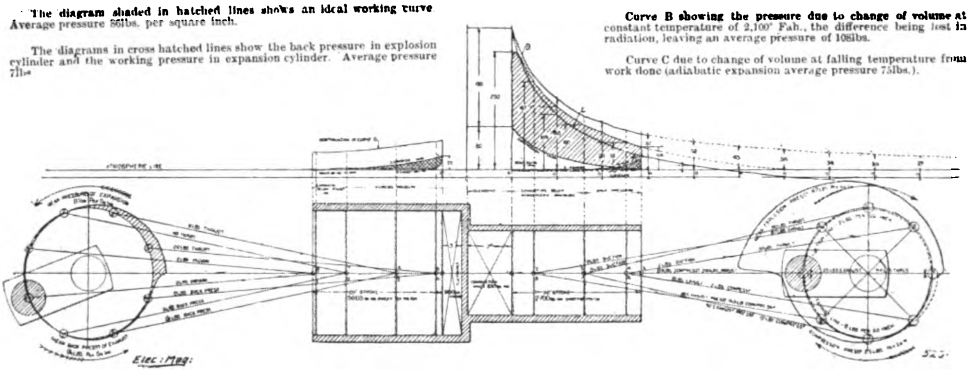


FIG. 2. DIAGRAMMATIC ARRANGEMENT OF 100-H.P. COMPOUND GAS-ENGINE.

efficiency is seven, and for a double-acting three-cylinder compound engine the value is twenty-eight, which is higher than any other.

It is from the point of view of economy that the compound engine scores to best advantage. A very clear representation of the method of continuing the expansion of the gases on being exhausted from the explosion cylinders is illustrated by the diagrammatic arrangement (Fig. 2) of a 100 h.p. compound engine. To demonstrate the limits to which expansion of the gases can be usefully carried, the isothermal and adiabatic curves B C are plotted above and below the actual working-curve; it will be noticed here that the expansion of the gases after maximum pressure has been reached denotes that combustion still continues to some extent during the expansion of the gases for a considerable portion of the stroke; this property of delayed combustion is much more in some gases than others, and may vary from the same town supply from day to day. Delayed combustion is, of course, an advantage in lessening shock and in giving to the engine a more sustained impulse, and more so if some means for utilising the power of the exhaust gases be available. A greater advantage in double expansion can be obtained from the slower burning carbonic-oxide gases, such as producer gas and blast-furnace gas, than with town gas, and with these the compound three-cylinder double-acting engine very nearly approaches the action of steam.

Some very interesting results have been obtained from an engine illustrated by Fig. 3; this is one of a series of three engines built to run on town gas or producer gas, and be interchangeable from one gas to the other, or *vice versa*, without effecting the working. The series of diagrams (Fig. 4) illustrates clearly the variable compression and explosion action obtained from the shaft governor and balanced cut-off throttle; the combined hand and governor control of this regulator is placed immediately between the gas-mixer and the distributing inlet valve. This engine is interesting also in being entirely without lift valves of any kind; the complete control of the gases to and from the cylinders being obtained by a single rotary valve, shown in cross-section by Fig. 5; this valve has opposite pairs of inlet and outlet passages that communicate alternately with the two explosion chambers at every half-rotation; and though but slowly rotating, this valve gives a quick and large port opening to both inlet and exhaust, and is always correctly timed and positive in action at any speed of the engine; it also has the advantage of not being affected by suction of the mixture supply or by back pressure from the exhaust, and is consequently particularly adapted for an engine working on the compound principle and governed by throttling the supply of explosive. The gas-mixer is constructed on the lines of the inspirator, and automatically adjusts itself for the supply of whichever gas is being used, and in the correct proportions for loads subject to frequent and sudden change.

The low-pressure cylinder is made large enough to expand the exhaust gases down below atmospheric pressure, and by this means a flushing current of cold air

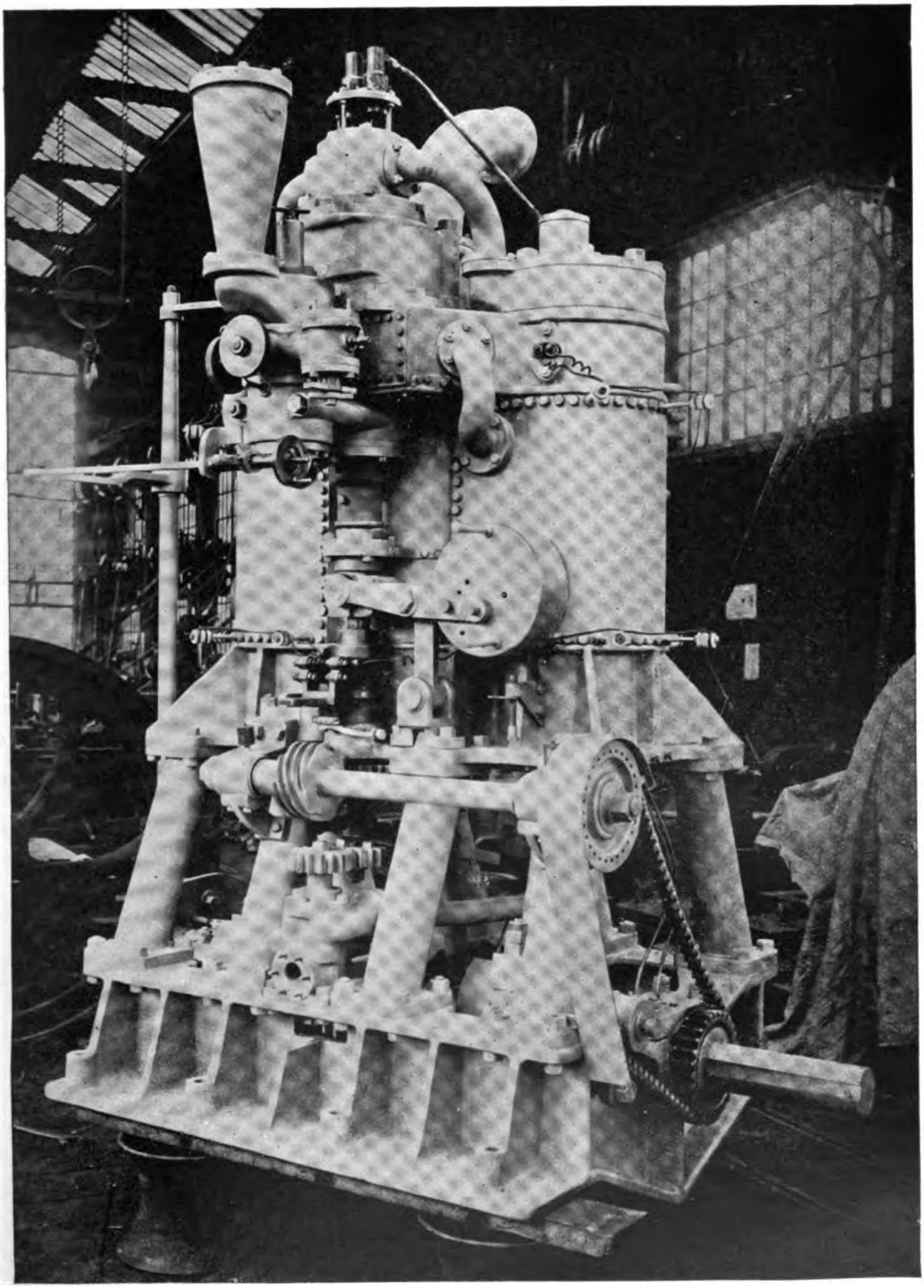
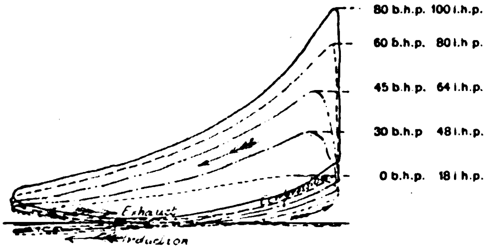
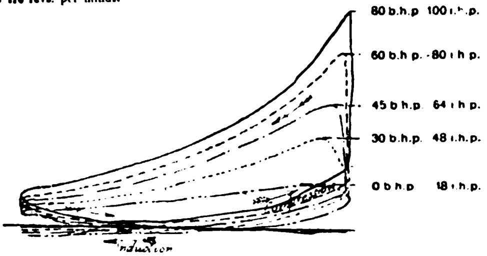


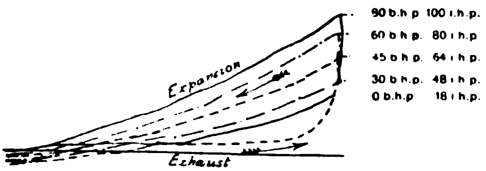
FIG. 3. 100-H.P. BALANCED COMPOUND ENGINE FOR TOWN AND PRODUCER GAS.



Diagrams from left-hand explosion cylinder Empty to full load. Speed 165 to 176 revs. per minute



Diagrams from right-hand explosion cylinder Empty to full load Speed 168 to 176 revs. per minute



Diagrams from explosion and scavenging cylinder Empty to full load. Speed 138 to 176 revs per minute.

FIG. 4. DIAGRAMS OF 100-H.P. BALANCED COMPOUND GAS-ENGINES.

is induced to flow through the explosion chambers at the termination of each exhaust stroke; this action is beneficial in securing a higher power duty from the engine when using diluted C.O. gas, but is not of particular advantage at any rate for small engines using town gas, except that it enables the engine to continue at full load without overheating of the surfaces in contact with the gases of combustion. The scavenging action is also useful in enabling the engine to run more evenly on light loads, making ignition absolutely certain, with high-tension plugs having a spark-gap of only one-twentieth of an inch, the sparking being continued for about forty degrees of the crank circle.

A similar engine to this, but arranged to run on oil or town gas, is illustrated by Fig. 6, which shows the connecting-pipes to the float-feed oil-cistern and gas-main. In this engine, when working with oil, a greater duty was obtained from the low-pressure cylinder than with gas; as much as 20 h.p. being indicated from the expansion cylinder out of a total of a 100 i.h.p. when on a brake-load of 80 h.p.; the consumption of oil being less than fifty pints per hour. As no advantage was obtained by scavenging, this action was cut out in obtaining this result. In an oil-engine of above 30 b.h.p., compounding is certainly an advantage in economy, besides giving such a nice balance, but, from the point of view of weight, of course exceeds somewhat the ordinary type; this is not, however, a matter of the highest importance though, for driving a dynamo. Fig. 7 shows some starting and compression diagrams taken from an oil-engine. Here is seen the action of compressed air on the explosion and expansion pistons; the compression diagram is seen to indicate a very sharp action with full opening of the valve, and that no loss takes place through leakage. It may be here stated that in this engine there is but the one valve for all three cylinders, thus displacing two inlet valves and at least three exhaust valves, leaving out of consideration

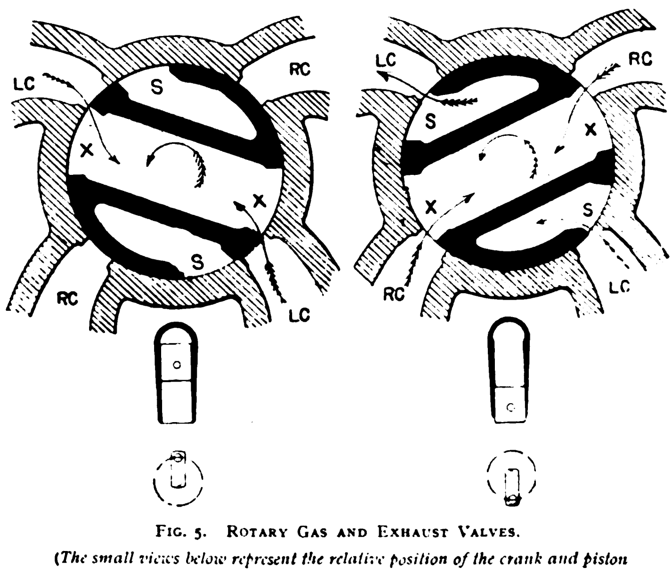


FIG. 5. ROTARY GAS AND EXHAUST VALVES.

(The small views below represent the relative position of the crank and piston to the valves.)

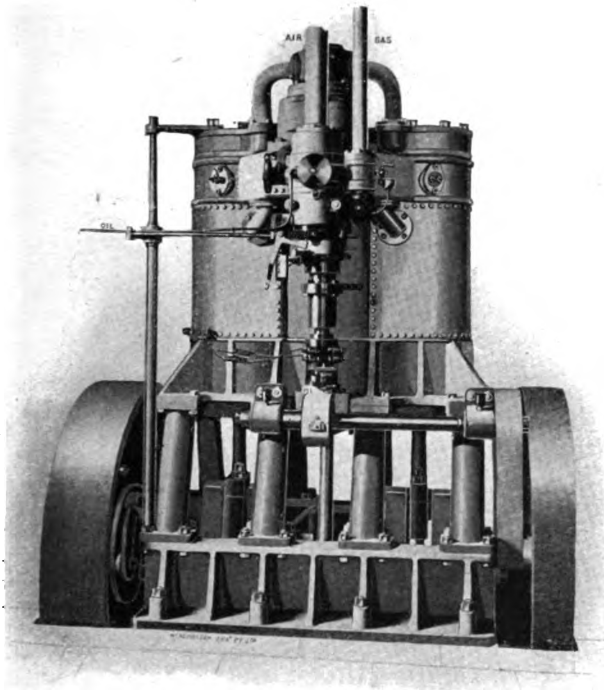
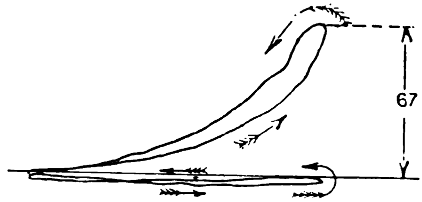


FIG. 6. 100-H.P. COMPOUND GAS AND OIL-ENGINE.

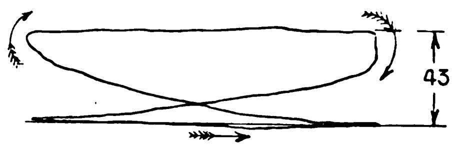
gas valves, cams, levers, springs, and gearing.

For large powers the double-acting engine illustrated by the sectional views 8, 9, 10, and designed on the compound principle to give off a continuous working load of 5000 b.h.p. on producer gas, is specially adapted for central stations, where economy of fuel and space is a first consideration. In this engine the scavenging action is retained, and all difficulty in cooling and lubricating the pistons obviated by introducing the water- and oil-feeds direct down the tail-rods, and thence into the pistons, where the water first runs over a weir before escaping by the hollow rods and crossheads into the receiving-cisterns at the side; the lubricating oil, which is fed down an inner pipe contained in the tail-rod, in this manner finds its way to the periphery of the pistons, and thus lubricates the cylinder walls equally all round. The distribution of gases to and from the two explosion cylinders is effected by plain water-cooled plug-valves; these rotary valves are held up to their seats by small pistons in connection with the cylinder, and by this simple means any adjustment required for wear or unequal expansion is automatically compensated for (this is shown in Fig. 10). The low-pressure cylinder is controlled by a water-cooled piston-valve, and is used only for the exhaust. The size of the cylinders is proportioned to give an average pressure of 65 lbs. per sq. in. on the h.p. pistons and 10 lbs. on the l.p. piston, and thus allows for a considerable margin for power above this; in order to keep the length of the engine within the narrowest limits the l.p. cylinder is given a reduced diameter by lengthening the stroke; this also assists in obtaining a truer balance.

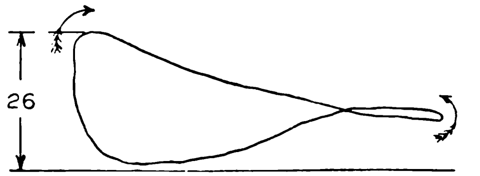
To avoid any uncertainty in the ignition, duplex electric igniters are arranged in separate firing-pockets provided with stop-valves so



Compression diagram, showing that rotative valve and pistons are gas tight. Taken with engine hot and at working speed.



Starting diagram, showing action of air in starting with engine cold on one of the explosion cylinders. Admission of compressed air during [illegible] of the explosion stroke.



Starting diagram, showing action of compressed air in starting with engine cold on the low-pressure cylinder. Pressure in receiver 100lbs. 5'28.

Elec: 1799

FIG. 7. STARTING AND COMPRESSION DIAGRAMS OF AN OIL-ENGINE.

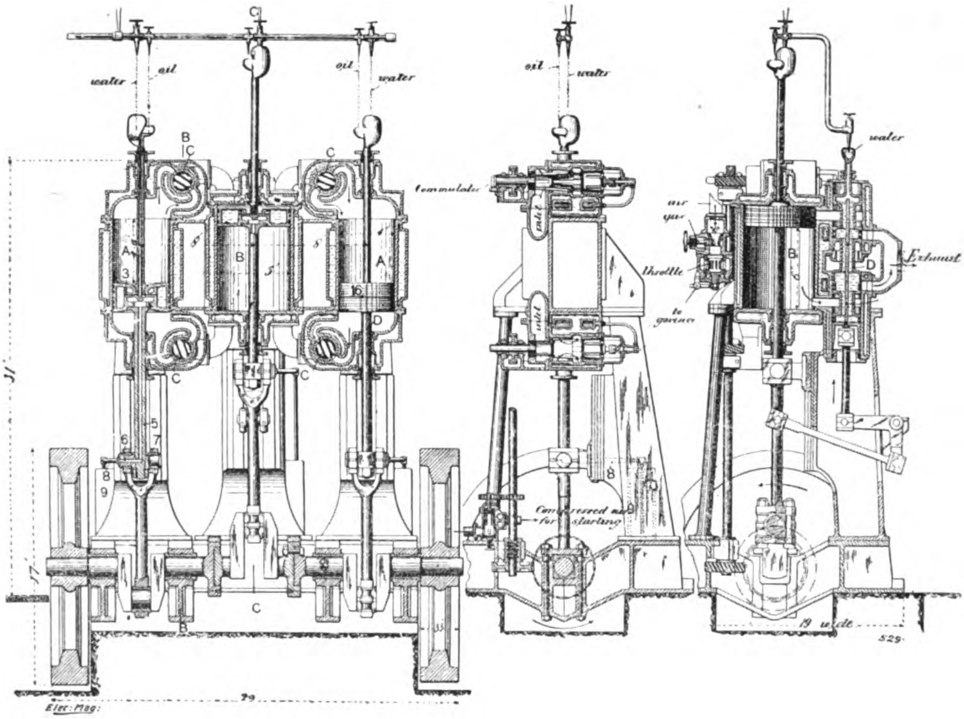


FIG. 8. FIG. 9. FIG. 10.

DESIGN OF DOUBLE-ACTING COMPOUND GAS-ENGINE OF 5000 H.P.

that a plug can be removed for examination or renewal without interfering with the working of the engine, and the sparking-coils, as in the smaller engines, automatically make all connections instantly on being placed in position. These are small but important considerations in large engines used for purposes where a shut-down on a minor count, such as a faulty igniter or coil, would entail a disproportionate inconvenience ; and it is due in a great measure to little improvements such as this that the gas-engine holds its present position.

A double-acting compound engine constructed on the lines of the illustrations occupies somewhat less space than a multiple-expansion steam-engine of the same power, and has all the advantages of double expansion with scavenging action, and thereby practically utilising all the potential power contained in the exhaust gases and resulting in a possible fuel economy on this account equal to as much as 30 per cent. And it should be borne in mind that an engine of this type gives eight equally distributed impulses during each cycle of two revolutions, and, owing to the perfect mechanical balance of all the moving parts, requires only comparatively light foundations ; this, combined with the economy in floor-space, places this engine to very considerable advantage, and when viewed in comparison with any other type is seen to best combine the three important points, of uniform torque, perfect balance, and economy—all advantages which should be found in a gas-engine of large power used in a high-class generating plant.

Several other forms of gas-engines on the compound principle have been dealt with experimentally from time to time, including engines by Daimler, Livesey, Crossley, Holt, and others ; but in each case in quite small sizes compared with the three-cylinder engine described in this article, and it is no doubt chiefly owing to this that in these engines expectations from double expansion have not been realised that should have resulted with properly applied methods.

Edward Butler.

LIQUID FUEL AND ITS APPLICATION TO ELECTRICITY WORKS

By FRANCIS H. DAVIES

In view of the peculiar conditions under which electricity supply is carried out, and the urgent necessity that exists in many cases of reducing works costs, the problem of the application of liquid fuel to this branch of the industry is always an interesting one.

If the average central station engineer is asked which of the many difficulties he has to cope with in working his station gives him the greatest anxiety and trouble, he will probably reply, the peak, or a fog-load; and there is no doubt that, under existing conditions of boiler-house plant, both these circumstances give rise not only to great inconvenience, but also to waste of coal.

Judging from the published lists of electricity supply undertakings, there appears to be but one concern in this country in which liquid fuel is used at all, and as present methods of coal-firing are admittedly unsatisfactory and wasteful at times of a sudden and great demand for steam, it seems strange that no serious efforts have been made to reduce this inefficiency by the above means, especially as it is generally admitted that upon such occasions the use of oil fuel in conjunction with coal would go far towards securing greater reliability at a reduced cost.

As a matter of fact, we are at the present time using the old methods of steam raising to meet new conditions that obtain in no other industry; and as long as we refuse to adapt our methods to these conditions, so long will we have to put up with those inconveniences and losses that from long precedent have come to be deemed part and parcel of electricity supply.

The exclusive use of petroleum as a fuel cannot be urged for electric lighting or any other heavy work in this country; the price fluctuates considerably according to the demand, and until oil magnates can be made to see that they are acting against their own interests by this method of procedure, it is best to leave considerations of its adoption upon a large scale out of the question. But this need have no effect upon its use within those limitations where it is so eminently suitable, viz. as an adjunct to coal-fired boilers at the peak, or during the first few and anxious minutes of a rapidly rising fog-load. Under both these conditions, or at any rate the last, it is necessary to force the working boilers and the stand-bys, which means an increase of fire, that with any solid fuel, stoked either by hand or machinery, is not only a question of time, but also of dexterity in the use of the tools and dampers.

The effect of fresh fuel in a furnace, whether fed by hand, coking stoker, or sprinkling stoker, is the temporary damping of the fires, and this at a time when the contrary is urgently needed, and seconds may be of importance. Also a rapidly rising load, even with mechanical stokers, means more men and an increase in cost out of proportion to the increase in output.

Contrast the occurrences in two similar stations during a fog-load, one being exclusively coal fired and the other possessing liquid fuel as an adjunct. The first case may be summed up in anxiety and rush, increased labour, low steam and volts, total disregard to efficiency, and black smoke; and possibly by the time steam is raised the fog has disappeared, and most of the extra fuel piled on, and all the extra labour, are wasted. On the other hand, with oil fuel we get the turning of a few taps, no rush, inefficiency, or smoke, no extra labour, and plenty of steam.

This is not overstating the case in any way; the first example may be seen in many large London stations during a heavy fog or unexpected increase in load, and the second is dictated by common sense and observation in foreign works where liquid firing is employed. In short, the case for oil fuel as an accessory may be summed up as follows:

Lower capital cost, as it is not necessary to instal so many stand-by boilers, considerable forcing by liquid fuel being

possible, and, compared with coal, economical;

Less risk of low steam, as, instead of damping the fire like fresh coal, petroleum instantly bursts into an intensely hot flame;

Economy in dealing with the peak load, as, unlike coal, the combustion of the extra fuel is entirely stopped directly it becomes possible. In ordinary cases, no extra labour is required for increased load, and forcing does not produce black smoke.

The first clause may be disputed upon the strength of the dogma that it does not pay to force boilers, owing to the ratio of heating surface per unit of fuel consumed becoming smaller than that the boiler was designed for, and therefore with it the amount of steam generated per unit. The case is, however, not exactly parallel, and, according to the opinions of experts, may be fitted with its own dogma to the effect that it is cheaper to uneconomically consume fuel for a short period, than to be burdened with the revenue charges upon large quantities of spare plant and extra land and buildings necessary for the negotiation of the peak load when burning fuel at the ordinary rate; of course in more furnaces.

Even with coal, provided it is of the best quality and regular in size, forcing may be economical in this respect; but never to the extent that it is with liquid fuel, owing to the fact that it cannot respond as quickly as the latter, and so cannot be fired at greatly increased rates.

As regards smoke, it should be noted that smokelessness is not at all an inherent quality of petroleum; on the contrary, it is an infinitely worse sinner in this respect than coal when improperly burned, and for this reason methods of combustion parallel in their inadequacy to those generally applied to coal are never attempted; the results would be appalling. As a matter of fact, ideal furnace conditions for the burning of oil are much easier obtained, which no doubt accounts for the advantages it possesses over coal from the point of view of smokelessness. It may be burned in any furnace, but highest efficiency is attained in one lined with refractory substances, as the full vaporisation of the oil is not then prevented by the cooling action of large areas of boiler-plate. Proper regulation of the air supply is essential for smokelessness, but this is not as difficult a matter with petroleum as with coal; the amount required may be taken as fifteen times the weight of combustible, and anything under this produces violent smoke and waste.

The constituents and calorific capacity of petroleum differ slightly with the locality in which it is found. The latter is given by sundry authorities in figures varying between 18,000 and 20,000 B Th U.

There are oil-fields in Russia, California, Texas, Timor, and Borneo, and, as a rule, their product is first subjected to processes that extract the lighting and lubricating oils of commerce, leaving the residue for power purposes; but this is not universal, Texas and Borneo oil being frequently utilised in their crude state. The components consist of a great variety of liquids, solids, and gases; the latter, however, are given off at once in the form of marsh gas as the oil rises from the well.

Quoting the figures given in Mr. E. L. Orde's paper read before the North-East Coast Institution of Engineers, the remainder upon analysis consists, in the case of Borneo crude oil, of:

	Per cent.
Carbon	87.90
Hydrogen	10.78
Oxygen	1.24

and other authorities give for American oils:

	Per cent.		Per cent.
Carbon . .	84.60	...	84.43
Hydrogen . .	10.90	...	10.99
Oxygen . .	2.87	...	8.34
Sulphur and Nitrogen	1.63	...	1.24

Californian petroleum has a peculiarity of its own in that it possesses a base of 30 per cent. of asphaltum, which is, of course, removed by treatment and sold as a by-product.

Roughly, the steam-raising capacity of petroleum can be taken, weight for weight, as twice that of average coal; it may be nearer 180 per cent., but, considering the saving that is obviously effected in labour, &c., this figure is a fair one upon which to base a commercial comparison.

The efficient burning of petroleum is a simple matter, as at present it is only possible in one way, viz. that of spraying it into the furnace in a highly atomised state. It was for some time common practice in America to simply pour it into the fire, but this was necessarily found very wasteful, and led to the adoption of present efficient means. The function of the atomiser is to break up the stream of petroleum into fine particles, and this may be done in several ways; for instance, by forcing it under steam or air pressure between the lips of two circular discs so arranged that the oil being fed just under the edge of the upper one is met by the steam or air and spread out into a fan-shaped spray, or, by aid of a perforated oil-pipe fixed inside and parallel to a larger steam- or air-pipe, and arranged so that the pressure meeting the oil streams at right angles, expels them in atomised form.

The question of the atomising agent, whether steam or air, is a troublesome one, as authorities differ on this point.

Upon the whole, however, the general opinion seems to be that, when the pressure required is low—that is, anything from 2 to 10 lbs. per sq. in.—air is the more suitable, as when mixed with the oil it assists combustion in a manner that steam cannot. But, for higher pressure, it has been ascertained that the steam required to run the air compressor becomes more than would be necessary if it were used as the atomising agent direct, generally from 3 to 5 per cent. of the total output, in which case any chemical advantages obtained by the use of air are outweighed by considerations of running efficiency and capital outlay on the compressing plant.

Whichever agent is employed, it is highly important that it should be hot and thoroughly dry; if steam, it should be superheated so as to preclude the possibility of water coming over and putting out the flame; if air, it must be hot, in order not to lower the temperature of the furnace. It is readily conceivable that, as the combustion of liquid fuel requires fifteen times its weight of air, this amount cannot be passed entirely through the atomiser; consequently, a great proportion has to be fed into the furnace at specially arranged points, and, as stated, it must be heated. This is done by passing the supply through large channels in proximity to the fire before it reaches the air outlets. It is essential for good atomising that the oil should be as little viscid as possible, and for this reason low-flash oils are preferable; but in any case preheating is necessary, and this is usually done by aid of steam coils placed in a tank through which the supply flows. About 180° F. is sufficient to ensure good atomising; if much greater heat is used, vaporisation will occur with low-flash oils. Preheating also has the desirable effect of separating out any water that may be present in the oil; and for solid impurities, that might be liable to choke the pipes, any ordinary strainer will suffice.

The case for liquid fuel has been ably dealt with in many places, and figures and details given that are impossible in a short *résumé*. It is a healthy sign that its adoption has been recently considered in connection with one or two large-power schemes, as this shows that central station engineers are becoming aware of the fact that they have in their midst at least a very valuable adjunct, which, if properly applied, will not only go far towards reducing both capital and running costs, but will also add, in some cases, greatly to the convenience and safety of supply.

Francis H. Davies

Readers are referred to the World's Electrical Literature Section at the end of the Magazine for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

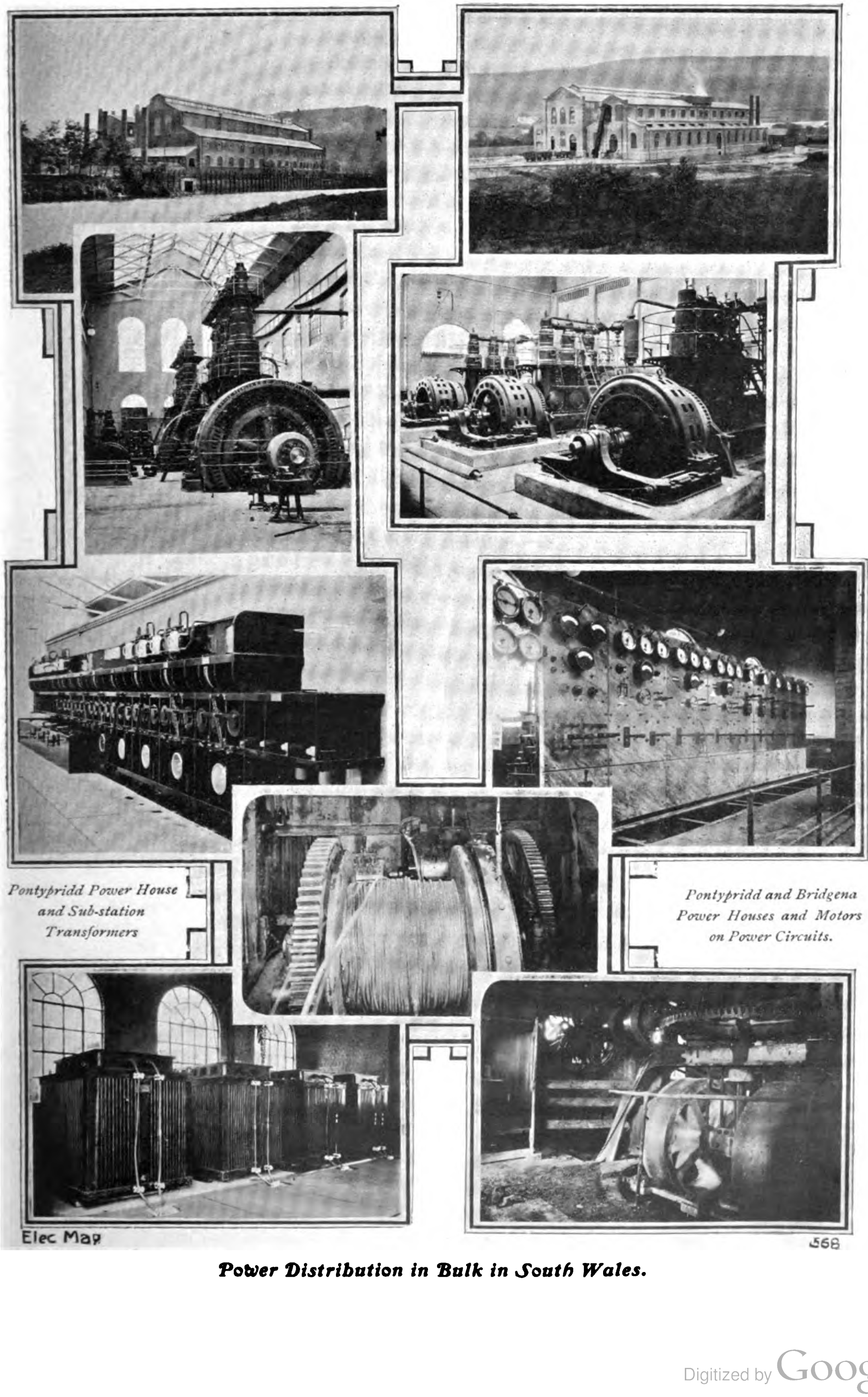
Power Distribution in South Wales

By EDMUND L. HILL, M.I.Mech.E., A.M.I.E.E.

ON August 6, 1900, Royal assent was given to the Act empowering the South Wales Electrical Power Distribution Company to supply energy over an area of 1034 square miles, comprising the whole of the county of Glamorgan and half that of Monmouth, and containing a population of well over a million. To-day the company is actively at work, with three generating stations supplying energy, and a fourth undergoing its final tests. Industrial Wales, kissed by the Spirit of Power, has at last awakened, and, like the other Sleeping Beauty, may be now expected to live happily ever after. The South Wales Power Company is a large undertaking, and it has entered on its work in a large and far-seeing way, and is already proving how short-sighted and unpatriotic were those who opposed, in a spirit of narrow parochialism, the distribution of electricity on a larger scale.

Of the company's generating stations, that at Bridgend was the first to get to work, and it commenced supply in May of last year. The present building—which is easily capable of extension—contains three Lancashire boilers by Danks working at 160 lbs. and fitted with superheaters and economisers. These supply steam to two Willans compound engines direct coupled to Westinghouse alternators generating a two-phase current at 3000 volts and sixty cycles. The alternators are excited by belt-driven generators. Each alternator is of 220 kw. capacity. A small 70 kw. Westinghouse machine direct driven by an Allen engine supplies the Sunday and some of the night load. The switchboard is of Westinghouse make, the power and the lighting panels being fed separately. The mains, of which about eight miles are laid, are Callenders' concentric paper insulated, lead-covered and steel-armoured, laid direct. Power is supplied in bulk to the Urban District Council of Bridgend, who distribute and resell it to numerous private customers for light and power. Energy is supplied to the Council from a transforming station in the centre of the town fitted with static transformers which transform the 3000-volt current down to 220. Similar sub-stations also feed the Parc Gwyllt and Angelton Asylums, which together take a large amount of energy, having 4600 8-c.p. lamps and nine motors, aggregating 41 h.p. between them. These motors drive fans, bread-making and washing machines, extractors, &c., and do all the routine work formerly done by steam. In and around Bridgend 300 h.p. of other motors are at work, driving brick-making, wood-working and other machines, stone-crushers, winches, pumps, fitting-shops and smithies, mortar-mixers, a brewery, stone saws, &c. That the advent of cheap electrical power has been a boon is proved by the fact that only one steam user is left in the town. Extensions are now under consideration which will increase the size of the station by 880 kw.

The Pontypridd generating station—at present the largest—commenced supply in March of this year. The building, the fine proportions of which are clearly shown in the accompanying photographs, is 258 ft. long by 146 ft. wide. Steam is provided by eight Niclausse boilers, built by Willans and Robinson at their Queen's Ferry Works, and each boiler is capable of evaporating



Pontypridd Power House and Sub-station Transformers

Pontypridd and Bridgena Power Houses and Motors on Power Circuits.

Power Distribution in Bulk in South Wales.

14,000 lbs. of water per hour. Superheaters are being arranged for. Coal is conveyed to hoppers above the boilers by a Graham-Morton electric elevator and conveyer, and the ashes fall into trams in the basement. Electrically driven feed-pumps are used with injectors for a stand-by. The plant at present at work comprises two Willans-Ganz (Bruce-Peebles) sets; triple expansion three-crank engines running at 150 revs. and 200 lbs. pressure direct coupled to three-phase alternators of 1800 kw. capacity, each working at 11,000–12,000 volts and 25 cycles. A third Willans-Westinghouse set of 330 kw. capacity takes the Sunday load. The alternators are excited by generators on the main shaft. Two 220 kw. Willans-Bruce-Peebles 110-volt continuous current sets supply all the energy required in and about the station as well as a few customers close at hand.

Electrically-driven surface condensers are used, the circulating water being obtained from the river Taff by motor-driven centrifugal pumps. A third 1800 kw. set and four more boilers will shortly be at work. The extra high-tension switchboard is of Ferranti make and is shown in the accompanying photographs. It is provided with five generator and five feeder panels, three of each of which are now in use. Another generator and two more feeder panels will be connected up almost immediately. A feeder-charging panel divides the generator and feeder sections. The synchronising gear is not shown, being in front of the platform for the convenience of the drivers.

Some thirty-six miles of mains are laid and at work, and are constantly being added to. They are Callenders' three-core 11,000-volt cables, paper insulated, lead-covered and steel-armoured, laid solid in bitumen in earthenware troughs. All mains are tested when laid at twice the working pressure, and it speaks volumes for Callenders' work that out of over sixty-six miles of mains tested altogether in the power company's area, not an inch has broken down, and only two joints have had to be re-made, both of which were originally made in bad weather. The station is supplying, or a supply has been arranged, at fourteen of the largest collieries in the Rhondda Valley, as well as numerous works, quarries, farms, &c., and three or four local authorities who take a supply in bulk.

The Cwmbran station, which serves the Monmouthshire portion of the area, commenced supply in June of this year. The buildings—which are arranged for an immediate extension—contain at present four Lancashire boilers by Galloways, working at 160 lbs. and fitted with superheaters and economisers. These supply steam to three Willans compound engines, direct coupled to Westinghouse 330 kw. alternators, generating a three-phase current at 2200 volts and 25 cycles. Two Willans-Bruce-Peebles continuous current sets of 40 kw. capacity each supply the exciting current for the alternators and provide light for the station, the engineers' and employees' houses, and work the pump and economiser motors. The switchboard is of Westinghouse make, provided with three generator and six feeder panels. The district within a two-mile radius of the station is supplied at 2200 volts. In the generating station are step-up Berry transformers, which feed the outlying districts at 11,000 volts. An extension of the plant is in hand which will bring the total capacity of the station up to 1870 kw. The mains, of which about thirteen miles are laid, are similar to those at Pontypridd and Neath.

The Neath station, which serves the western side of Glamorganshire, will eventually be the same as Cwmbran. At present a plant similar to that at Bridgend is being got to work to satisfy the immediate large demand for a supply in bulk for lighting purposes made by four of the local authorities near by. This plant will be running early in July of this year, while the rest of the station will be in operation during the autumn.

The system of distribution is very complete and well thought out. The mains are laid in a series of rings, some starting from and returning to the generating stations, others starting from and returning to "junction stations" at different points. No tee-joints are made in the extra high-tension cables; in every case they are looped in and out of the sub-stations and controlled by oil break-switches, so that any section of main may be made dead for repairs or new connections. The transforming stations, of which there are about thirty at present, vary in size from 100 kw. to 900 kw. capacity. They are all fitted with Westinghouse or Berry transformers, reducing the pressure to 440 or 220 as required, and contain extra high-tension plug and "sparklet" fuse-boards and low-tension fuses. One only, so far, has motor-generators. This sub-station has two Westinghouse motor-generators with 440 volt three-phase motors driving 220 volt direct-current generators. This station supplies a large steel works which already had a number of direct-current motors and arc lamps installed, and did not want to change its system. Other direct-current sub-stations will shortly be at work supplying tramways, which are growing rapidly in South Wales.

Overhead mains are run in a good many cases connecting consumers to sub-stations, but so far nothing over medium pressure,

550 volts, has been employed in such cases. The use of overhead mains carrying extra high-tension current up to 20,000 or 25,000 volts is, however, receiving the attention of the company's engineer, Mr. Graham Harris.

The application of high pressures direct to the motor terminals is becoming common and is certain to extend. Up to now, the power company have not supplied above 2200 volts. The Cwmbran station has a three-phase 400 h.p. motor, built by the Electric Construction Company of Wolverhampton, connected direct to the 2200 volt mains driving two pairs of rolls for steel wire making. The same pressure is being freely taken below ground at collieries to save the heavy cost of low-tension mains in the shaft, but in these cases it is transformed at or near the pit bottom. The power company expect very shortly to have many of the larger size motors at work connected directly to their 11,000 volt mains. The saving in transformer losses will more than compensate for the higher initial cost of the motor, and the direct use of high pressures will simplify the whole system of distribution and minimise the risk of breakdowns.

Industrial South Wales has recently awakened to the value of "electrics," and a very rapid development is taking place. Three years ago electricity was hardly used at all except for lighting. To-day there is scarcely a large colliery or works that either has not already a good deal of power at work or under consideration.

The South Wales Power Company at its inception was disbelieved in and smiled at by many. To-day it is cursed because it cannot supply everybody who is clamouring for its power at a moment's notice. The district is an ideal one from the power company's point of view. The more important collieries and works are fairly near together and each requires a large amount of power. Apart from the trunk mains (which must always necessarily be expensive to lay down) the distribution is cheap, as each sub-station is made a centre for distributing a very large amount of power to, at most, three or four customers. The distribution, moreover, can usually be done by bare overhead wires. The uses to which electricity can be put in collieries with economy comprise every operation hitherto performed by steam, including the winding. A motor will drive the fan far better than a steam-engine, as there is no shock caused by reciprocation. For underground work, haulage, pumping and coal-cutting, "electrics" have everything in their favour as compared with steam. In the one case a cable, perhaps three inches in diameter, will convey power with a loss of only 5 per cent. to various motors underground that work with a loss of only 12 per cent., or a total loss of 17 per cent. between the power company's sub-station and the work to be done. In the other case, clumsy and massive steam or compressed-air pipes are needed, and engines requiring a large amount of room, the combined losses in which are frequently from 75 per cent. to 80 per cent. For all surface work, too—fitting-shops, smithies, rubbish-tips haulage, telpherage, saw mills, brick-making plant, creepers, &c. &c.—the polyphase motor is a most efficient and economical substitute for the steam-engines (too often old and decrepit), and the frequently unlagged long lengths of steam main.

It is also of immense advantage to the collieries to have cheap and reliable power always "on tap" and paid for only as used. It saves them a heavy capital expenditure in generating plant; it makes them secure against fear of stoppage of their fans and pumps in case of a strike; it saves them money daily in ordinary working and still more money on Sundays and stop-days. It enables them to sell all the coal they raise instead of burning from 6 per cent. to 8 per cent. of the total in raising the balance, and it saves them from spoiling their beautiful hills and valleys by smoke and steam. Though Great Britain as a whole is sadly behind the Continent and the States in the use of "electrics," there are not wanting signs that this reproach will soon be a thing of the past. The rapid progress and development of the South Wales Electrical Power Distribution Company is one of the happiest of these indications, and all must hope that its example will shortly be followed by the other great companies that now have powers over most of industrial Great Britain.

Electricity in Spinning and Weaving.

By J. GARCIN.

A PRIME condition for the satisfactory working of the greater part of textile machinery is absolute regularity in the speed of the rotating parts, the load often varying as much as 80 per cent. of its total value. Where the prime mover is a steam-engine, fluctuations of speed occur due to the periodic variation in the steam-pressure, the irregular motion of the reciprocating parts and the variation of load. When electricity came into the field, the solution of the constant speed problem became so much easier that it is surprising that the merits of electrical driving should not have appealed sooner to manufacturers, many of whom, no doubt, were scared in the beginning by the relatively

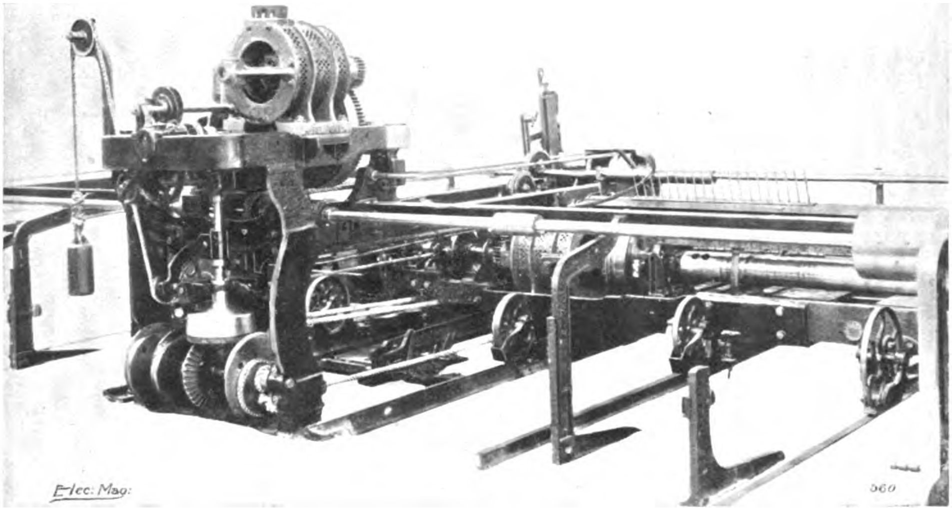
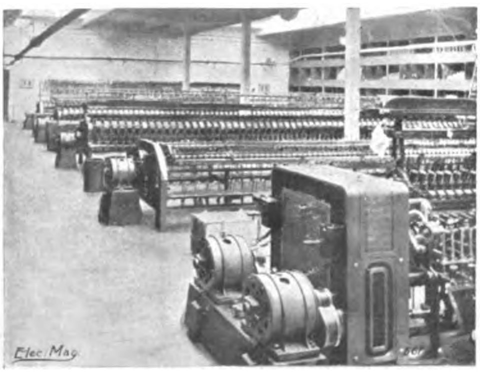
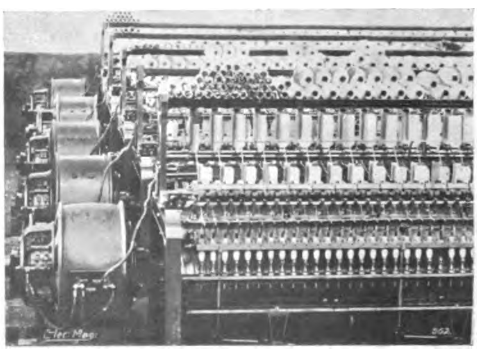


Fig. 1. Electrically Driven Self-acting Mule.

high cost of dynamos and motors. At present, however, probably on account of constructional improvements and the introduction of polyphase machinery, electricity is gaining ground everywhere, and some mention should be made of the results achieved in this particular direction.

In some of the first electrical textile installations, synchronous motors were used, and the driving power necessary for whole groups of machinery was generally concentrated in a small number of motors; the idea of this arrangement being to improve the efficiency of the motors and reduce first costs. The modern tendency is to put in a larger number of smaller driving units, to secure greater simplicity in the driving operations, individual movements being thus controlled independently of each other. The advantage of thus distributing the driving power in proportion to the number of separate moving parts is specially noticeable in the case of machines of more than 1 h.p. working intermittently. The ease and simplicity with which polyphase motors can be handled, their great regularity under varying loads, and the advantages derived from the suppression of commutators and starting-resistances, render these motors specially suitable for the working of textile machinery, which has to be handled by workmen possessing no special knowledge of electricity. When provision for lighting introduces no special complication, a low cyclic frequency should be adopted, as it allows of motors being designed of very high efficiency at the convenient speed of, say, 750 r.p.m., capable of being coupled to the machines direct, or at any rate with only one intermediate gearing. Some precautions should be taken with the leads, in consideration of the dust





Figs. 2 and 3. Electrically Driven Spinning Frames.

Fig. 4. Electrically Operated Weaving Shed.

and other inflammable matter scattered in the air. Where triphase star-wound motors are used, for instance, the leads can be taken under the flooring to the motors, connecting them to the star-terminals at the top. In this manner they are protected along their whole length, and a simple key-switch may be used for closing the circuit. Some manufacturers object to electricity on account of the necessity of starting each motor individually, but, of course, the plant can be designed so that all the motors start at the same time as the generating unit, just as in the case of a teledynamic transmission. In all cases the use of rheostats and slip-rings for the rotors should be avoided as much as possible. A brief survey of the principal machines operating at textile factories will show the advantages and adaptabilities of the electric drive. Fig. 1 illustrates a spinning frame, or self-acting mule, in which there are two separate movements requiring two motors. One of these is shown on top, and imparts a to-and-fro motion to the carriage, the velocity being regulated by a rope and eccentric; the other, placed on the chariot, drives the drum actuating the spindles. Electric driving materially increases the output, as intermediate gearing is dispensed with, and the result is a great saving of time. In

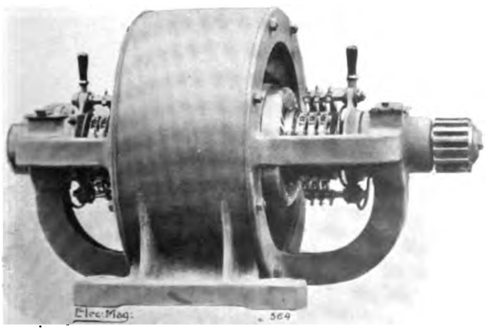


Fig. 5. Special Motor with Double Armature Windings.

Figs. 2 and 3 other types of spinning-frames are shown, and here again electricity scores. A constantly variable velocity should be imparted to each machine, in order to wind the thread regularly and at constant tension throughout the whole length of the spindle. As the winding is done on a cone, the tension of the thread does not remain the same if the rotation of the spindle be kept constant, as in the case of a purely mechanical drive. By employing an electric motor, the speed can be constantly varied, according to the diameter on which the thread happens to be winding, at any moment; this regulation is effected by means of a rheostat, whose lever is connected to the mechanism in such a way that the speed is maximum for the smallest diameter and minimum for the largest.

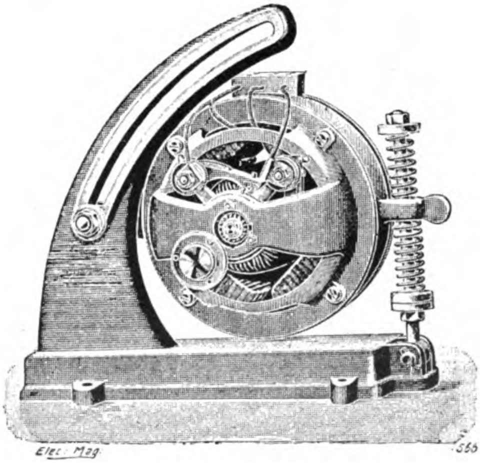
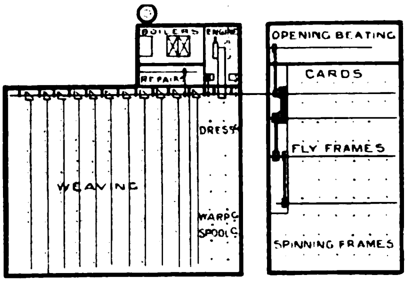


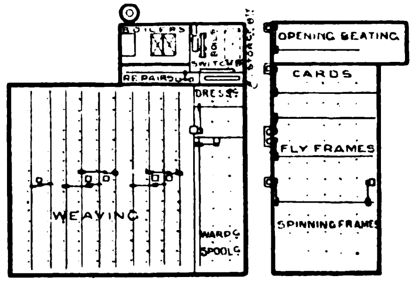
Fig. 6. Motor for Driving Weaving Looms.

With mechanical transmission the constant speed adopted must necessarily be that corresponding to the largest diameter. In this particular case, and contrary to practice with other textile machinery, direct current has decided advantages over alternate. A field rheostat can be used, giving rise practically to no loss. In electrically operated weaving-looms (Fig. 4) the advantages are higher acceleration at starting and more uniform rotation, resulting in increased output and a better quality of tissue. However, when driving looms with only $\frac{1}{6}$ or $\frac{1}{2}$ h.p., the electric transmission is generally more expensive and less efficient than its mechanical rival, though this is by no means universally true.* In the

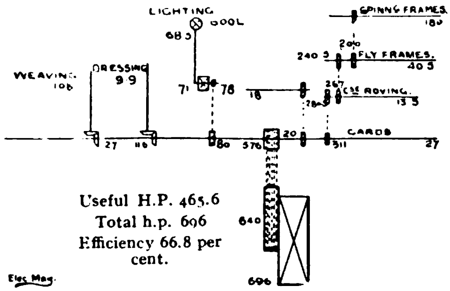
* From particulars received by the author, it appears that in a German firm the monthly expenditure for embroidering machines, driven by $\frac{1}{4}$-h.p. motors, is only about seven marks per machine. This is another example of the advantage of the individual drive.

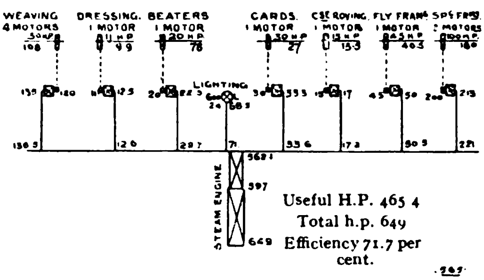


Mechanical Transmission.



Electrical Transmission.





Figs 7 and 8. Comparing Mechanical and Electrical Driving of a Mill.

printing of fabrics the necessity for a broad range of speed introduces a difficulty for the successful application of electricity. One way of surmounting this is to provide two windings on the armature, by combining which several different speeds can be obtained. Fig. 5 is a view of a type of motor constructed by the "Société Alsacienne" of Belfort, which has two windings and two commutators. By making these work independently, in series or in opposition, speeds are obtained of 250, 460, 600, or 950 r.p.m. By adding a rheostat, any speed from 250 to 1100 r.p.m. can be obtained. Fig. 6 shows a type of motor specially designed for weaving-looms by the Gesellschaft für Electrische Industrie of Karlsruhe. Motion is transmitted to the looms by belting, and the position of each motor can be adjusted according to the belt-tension. The same firm has also introduced ball-bearings for motors of 0.25, 0.5, and 1 h.p., in favour of which an annual saving of about 20 per cent. in the energy bill is claimed. The firm has adapted these ball-bearings to motors of 200 h.p. A little calculation will, perhaps, enable the reader to form an impartial idea of the respective merits of electrical and mechanical driving in a textile works. The following diagram and estimates relate to a plant in actual operation, and the author has controlled them personally. Figs. 7 and 8 are two different solutions of the same problem of power-distribution in a factory. In the first and purely mechanical solution, one long line of shafting extends the entire length of two separate buildings, being rope-coupled to a Corliss tandem compound engine of 600 i.h.p. From one end of this shaft motion is transmitted through bevel-gearing to a series of transverse shafts, each of which actuates two rows of weaving-frames while the other end drives spinning and other machinery in the neighbouring building. In the electrical solution (Fig. 8) the main-shafting is replaced by a number of electric motors, and the steam-engine is coupled direct to a 500 h.p. alternator. The simplicity and compactness of the electrical solution are apparent even on these diagrams. The respective costs of the two plants would come out somewhat as follows:

Mechanical Transmission.

	£
Steam-engine, 500 h.p., 75 revs. per min., with rope fly-wheel	2600
Shafting, pulleys, gearing	2000
Main wall for supporting transmission, masonry piers, &c.	600
Ropes	240
Housings for ropes (50 × 5, 250 m². at 32*s*.) + walls and piers	400
Dynamo for lighting, with separate transmission	280
Storage battery	98
	£6218

Electrical Transmission.

	£
Steam-engine, 500 rated h.p., at 100 revs. without fly-wheel	2000
Secondary transmission, shaft, pulley	800
Alternator of 500 h.p., motors, conductors, switchboard, &c.	3200
Storage battery	98
	£6098

As regards first cost of installation, therefore, the balance is slightly in favour of the electrical drive. The next question is that of the total efficiencies of the two plants, a very important item, which, unfortunately, cannot be predetermined with great accuracy. In different works it has been found that the power necessary for driving the shafting varies from 15 to 50 per cent. of the total power employed. In the case under consideration special tests were instituted to determine the loss by transmission, and these, jointly with information collected from factories placed in similar conditions give sufficient authority to the conclusions summarised in the accompanying diagrams. The efficiences would then be as follows:

	Mechanical transmission (Fig. 9).	Electrical transmission (Fig. 10).
Useful power	465.6 h.p.	465.4 h.p.
Indicated horse-power	696.0 h.p.	649.0 h.p.
Efficiency	66.8 %	71.7 %

In addition to the above advantages, the absence of gearing subject to wear between the generating and utilising units greatly diminishes the costs of maintenance and the risks of injury to the men in charge. Further experience has shown that the working of the machinery is far more regular, and consequently the finished product of better quality, with electro-motors than when belting is used, a result which could be easily foreseen.

ELECTRICITY AT THE INSTITUTE OF MINING ENGINEERS.

As in every other branch of engineering, electricity is making rapid strides in connection with mining. The remark of the author of one of the papers read at the recent meeting, to the effect that while a short time ago papers before the Institute were confined to describing the difference between shunt and series wound machines, now the meetings might be mistaken very often for those of the Institution of Electrical Engineers, was fully justified. At the two annual meetings of the Institute it is the practice to have a large number of papers for discussion, and this has led to the division of the meeting into two sections, under two chairmen, the papers set down for reading each day being divided between the two. At the recent meeting, when the members divided, after the newly elected President had read his address, nearly the whole of those present followed the reader of the first of the electrical papers into the room set apart for them. There were two papers read dealing with power: one

THE CHELSEA POWER HOUSE IN COURSE OF CONSTRUCTION AND EQUIPMENT, WITH WESTINGHOUSE PLANT.

on the Report of the Departmental Committee of the Home Office, on the use of electricity in mines; and the other on the relative advantages of Three-phase and Continuous Currents for Mining Work. The Committee of the Home Office, who sat for several months, had prepared a very able report, accompanied by one hundred odd rules, which are, if Parliament sanctions them, to be applied to the use of electricity in mines. The feeling of mining engineers and colliery managers is that, while the Report is all that could be wished, the rules are much too numerous, and the author of the paper dealing with the subject—Mr. S. F. Walker—had been asked if he could not condense them. This he did, and his proposed rules, with an explanation of his reasons for suggesting them, formed practically the substance of the paper. The suggested rules, stated shortly, ordained that pressures above 3000 volts were not to be used at all, nor pressures above 650 volts, outside the main air-ways; that earth was not to be connected to the conductive system, that all metals containing electrical apparatus were to be connected to earth, all the above to be subject to exemption by H.M. Inspector of Mines for the district; that all apparatus about a mine should be so fixed that no part should be unduly heated, that no arc should be formed and no shock obtained in the ordinary working of the apparatus; that all cables should be tested periodically for insulation, and the results entered in a book; and that all cables, motors, and other apparatus should be under proper control. The author also discussed the question of earth, antagonistically to the view apparently taken by the Committee. In the discussion, there was, naturally, a considerable difference of opinion, but every one was dissatisfied with the rules of the Committee. It was pointed out that in some districts it was very difficult to get earth at all, while in others it was very difficult to keep earth out of the circuit. Some speakers among the electrical engineers thought that some rules were necessary, while the colliery managers were of the opposite opinion. One colliery manager pertinently asked why he should have to obtain the permission of the inspector to alter his electrical pressure, when he had not to do so for his boiler pressure, and he was immediately responded to by an inspector that if an explosion of his boiler occurred the inspector was promptly on the ground. It was also stated by some of the mining men that if the Committee's rules became law some of the collieries where electricity was at present in use, and which were only able to be worked economically by the aid of electricity, would have to be closed.

GENERAL POWER NOTES.

Snoqualmie Falls Plant.

THIS plant enjoys the unique distinction of operating some 300 ft. below a river bed. In the majority of American and Continental power-houses the station is built at the surface, and the water-wheel sunk in a pit, but in the present instance the water is directed to the generators in a chamber excavated at the depth mentioned below the falls. The present plant has a capacity of 10,000 horse-power, and will be increased as necessity arises. The Snoqualmie Falls and White River Power Company are also laying down a large plant for 10,000 horse-power on the White River. Both deliver current to the same transmission system by independent circuits, the line comprising 7-strand aluminium cables mounted on porcelain insulators. The Company supply current only in large quantities to manufacturing plants and electric railway companies. The principal cities supplied are Tacoma, thirty-four miles distant, and Seattle, twenty-five miles distant. A full description of the plant appeared in *The Electrical Review*, New York, June 18.

Power Transmission in Utah.

IT frequently happens in the Western States of America that the tail race of a hydro-electric plant is the head works of an irrigation system supplying thousands of acres of rich soil with water through extensive canals. Such a combination of power generation and irrigation has recently been put in operation by the Utah Sugar Company on the Bear River. Two large canals are utilised, both of which can be independently or conjointly drawn upon. The two canals run parallel to each other, and are connected by an inverted syphon, and the power-house takes its water for the turbines at the lowest point. In our next issue we shall give a section and plan of this arrangement. At present there are installed two 1400 horse-power Leffel Turbines, coupled to 750 kw. Westinghouse 3-phase alternators.

Use of Exhaust Steam for Generating Power.

ACCORDING to the *Elektrotechnische Rundschau*, a new process for utilising exhaust-steam for producing power in low-pressure steam turbines, including an exhausted accumulator (Rateau Patent), has been developed by Balcke and Co., Ltd., Bochum, Germany. The device is especially intended for utilising the exhaust from intermittently working engines used in mining. While an ordinary condensation in most of these engines will have but a very slight effect (the vacuum in the cylinders being of no importance and considerable condensation losses being caused by a high cooling of the steam-cylinder during stoppages), the new outfit will allow of the exhaust from these machines being utilised to such an extent as to secure a better saving than, for instance, in the case of a satisfactory condensation in a high-class triple-expansion machine. The exhaust-steam from a hauling machine will readily allow of 500, and that from a reversing machine of 1000 electric h.p. being generated. Moreover, the first cost is much lower than that of a high-tension steam plant of the same output, while there are no expenses for operation worth speaking of. The principle of the process consists of storing the exhaust-steam issuing in very variable amounts from the intermittently working engines in an exhaust-steam accumulator, and of transmitting same in a uniform manner to a low-tension turbine. The latter, after receiving the steam, as a rule at atmospheric pressure, will give it off again at the condenser pressure.

A classified list of Traction and Transport articles will be found in the World's Electrical Literature section at end of magazine.

ELECTRIC TRACTION FOR RAILWAYS.

VI. Westinghouse 1-Phase System.

By W. M. MORDEY, M.Inst.C.E., M.I.E.E.

(*Continued from page* 493.)

IT has been for some time evident from various notices in the technical journals that the Westinghouse Electric Co. of Pittsburg, U.S.A. has been giving attention to the development of 1-phase plant for railway traction under the guidance of Mr. Lamme. At a comparatively early stage, arrangements were actually made by the Company for equipping a considerable length of railway with this apparatus, but this fell through for some reason which was not technical.

A certain amount of information has now become available as to the direction in which the Company has been carrying on its investigations, and there is little doubt that those who are able to join the expeditionary force which the Institution of Electrical Engineers is sending out to the States in a few weeks. will have the advantage of seeing examples of this work.

If simplicity is the best test of invention —and we think few will deny this--then it appears that the Westinghouse Company's 1-phase methods leave little to be desired so far as simplicity is concerned. They appear to have attained their results by the careful proportioning and adaptation of old designs rather than by the introduction of anything very new or startling. Like Mr. Finzi, Mr. Lamme has fallen back on the simple laminated series motor of direct-current type, rather than on any form of alternate-current

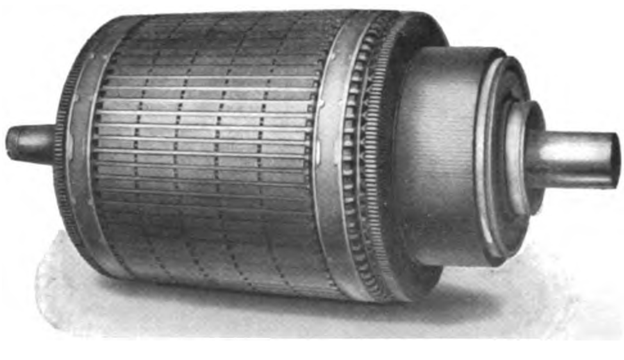


Fig. 1. Armature of Westinghouse One-phase Railway Motor.

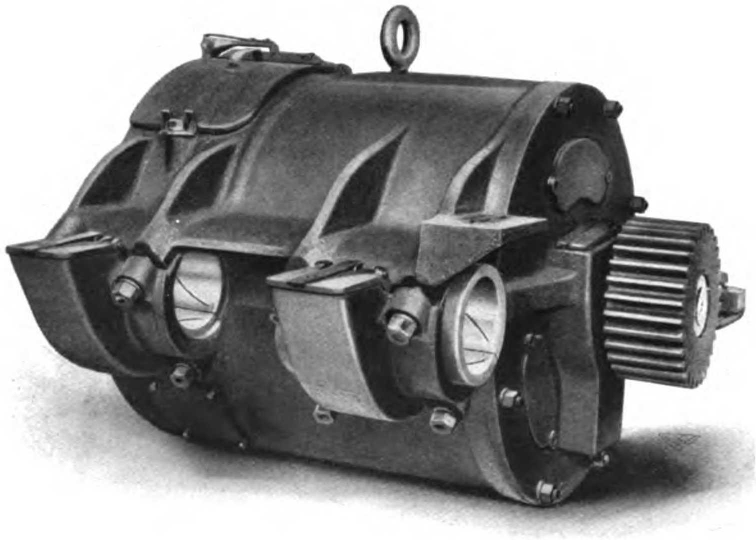


FIG. 2. EXTERNAL VIEW OF WESTINGHOUSE ONE-PHASE RAILWAY MOTOR.

motor, and, like some of those other workers, he has sought relief from some of the ills of commutation by using a low periodicity. So far as the armature of this motor is concerned, it is externally just like a direct-current armature, as will be seen from Fig. 1, which represents the armature of a 100-h.p. motor with its shaft and commutator. We understand that in the first motors made. the commutator leads were of considerable length, and of a high resistance, with the object of keeping down the current that circulated through the brushes; in some cases these leads being tapped off the "pulley end" of the armature and brought back through the spider to the commutator. In the motors now under construction, the writer is informed that these commutator connections from the far end of the armature are being brought to the commutator through the same slots as the ordinary winding, these commutator leads being placed at the bottom of the slots below the ordinary winding. It is stated that this is done merely for convenience to get room for a long lead, but it seems quite possible that this return lead may be used in the manner of a Sayers' commutator connection—which it resembles—giving an e.m.f. to facilitate commutation. It seems doubtful whether high resistance commutator connections are of much use either in direct current or alternate current machines but this is a point which cannot be conveniently discussed now. They have often been suggested.

The field magnet system resembles an ordinary direct-current tramway motor externally, as will be seen from Fig. 2, but internally it is furnished with a counter acting winding passing through holes or slots in the pole faces in the manner best known in connection with the name of Professor Ryan, and for the same purpose.

Fig. 3 shows the speed, efficiency, horse-power, and tractive effort curves of this motor, tested at 200 volts, twenty-five periods per second. The weight is given as 4300 lbs. complete with gears, gear case, and axle bearings. This compares with the 4800 lbs. weight of the Westinghouse 100-h.p. direct-current motor (Type 83) as used on the Mersey Electric Railway. This affords another confirmation of the statement that 1-phase motors may compare favourably with direct-current motors. In the present case, however, an addition must be made for the weight of the transformer which must be carried on the train, although we have no doubt that the Westinghouse Company would not decline to make

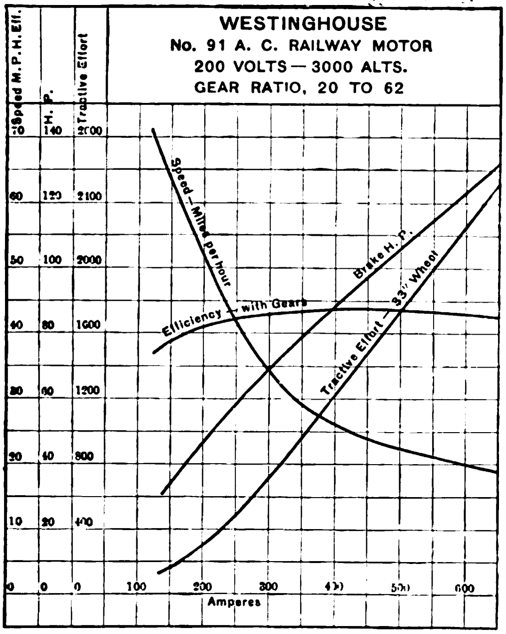


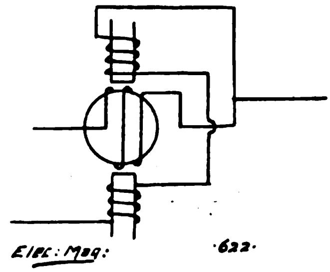
FIG 3. SPEED CURVES OF WESTINGHOUSE ONE-PHASE MOTOR.

motors to work direct from the high-tension mains, and so avoid the need for transformers. It is, however, not easy to see how this can be done with an ordinary series motor on account of the commutation difficulties with high volts on the commutator. The Union Company, as explained in a previous article,* has avoided these difficulties in another way.

However, 1-phase traction has so many advantages that if the series motor, pure and simple, is found to be the best, it is not likely that the extra cost and weight of the transformers would stand very seriously in its way.

The method of control adopted by the Westinghouse Company is shown diagrammatically in Figs. 4 and 5. What is called an induction regulator is used. It is essentially a transformer in which one winding (or one part of the winding), with its core, is movable with respect to the other. We are familiar with this device in this country where it has long been made by Mr. Cowan. The Westinghouse Company applies this device in the manner shown in the diagrams. In Fig. 4 the maximum voltage produced in the secondary of the regulator is arranged to oppose the voltage of the main auto-transformer. With the primary of the regulator moved round 90° as in Fig. 5, the voltage of the secondary is zero, so that it neither aids nor opposes the voltage of the auto-transformer. By a further movement to 180° from the first position (not shown on the diagram) the voltage of the regulator will help that of the auto-transformer. For starting the train or car, the regulator is placed

FIG. 5. DIAGRAM OF WESTINGHOUSE ONE-PHASE CONTROL.



so that its opposing voltage is a maximum. It is then gradually moved until a suitable position is reached for the load that is to be carried. There is thus a smooth and perfectly graduated method of control by back e.m.f., thus avoiding the jerkiness as well as the wastefulness of the ordinary direct-current method of resistance control.

For reversing the direction of the motor, the process is the same as with a direct-current motor, namely by crossing the armature or field connections.

Fig. 6 shows two 100-h.p. motors mounted on a standard truck. It is not distinguishable from an ordinary direct-current equipment. Fig. 7 shows a long double truck car equipped with four such

* *Elec. Mag.*, No. 2, p. 161.

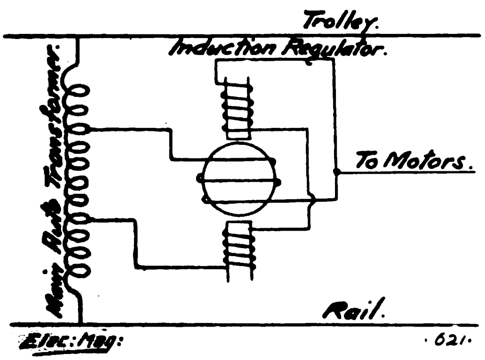


FIG. 4. DIAGRAM OF WESTINGHOUSE ONE-PHASE CONTROL.

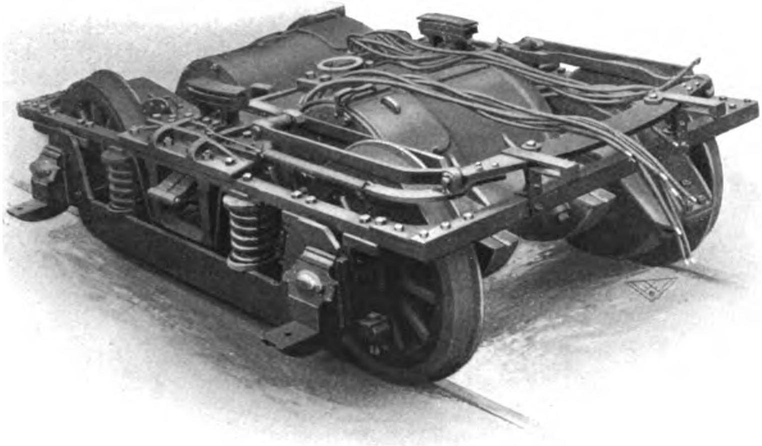


FIG. 6. WESTINGHOUSE ONE-PHASE MOTORS MOUNTED ON STANDARD TRUCK.

motors. This is the car which has been used during the last six months for the experiments at Pittsburg. It has been worked in connection with a trolley line supplied at 1000 to 1100 volts and twenty-five periods per second, the transformers on the car reducing the pressure of the motors to about 220 volts. The braking is by ordinary air brakes driven by an air-compressor worked by a 110-volt motor, the transformer for which also supplies the necessary lights in the car. Lighting at so low a periodicity as this cannot be very satisfactory as there must be a visible flicker, but no doubt this can be avoided by using a small rotary transformer for the lights to give a direct current for the lamps.

The Westinghouse Company emphasises the fact that it is quite feasible to use multiphase generators for this work, and so avoid the extra cost of having 1-phase generators. So far as this extra cost is concerned, the point is not of great practical commercial or engineering importance, except for its bearing on the

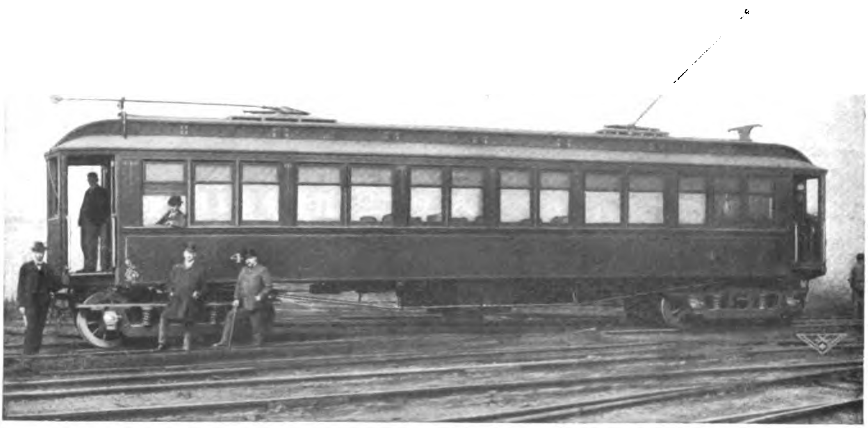


FIG. 7. DOUBLE TRUCK CAR FITTED WITH FOUR ONE-PHASE WESTINGHOUSE MOTORS.

utilisation of the 3-phase generators already installed for traction work. It is true that 1-phase generators are more costly than 3-phase, but the difference on the whole generating equipment is not very important, and is balanced by economics due to simpler and less expensive switching gear, transformers, and the like.

It will be obvious that these Westinghouse 1-phase motors, unlike induction motors, if wound for suitable e.m.f. can work equally well on alternate-current or direct-current circuits. This is a point of great practical importance as it enables trains to pass over lines equipped for either system. This is a further advantage possessed by the 1-phase system over any multi-phase system both as regards the overhead equipment and the motors.

The Westinghouse Company no doubt had this double purpose in view in winding their motors for something between 200 and 250 volts, as this allows of their being used on 500-volt direct-current circuits.

There will shortly be a practical and important demonstration of this feature of the Westinghouse equipment, the Pittsburg Company having received a contract to equip ten of their cars each with four 75-h.p. 1-phase motors to work on a line of the Indianapolis and Cincinnati Traction Company. The motors are to be for 250 volts and the maximum speed is to be forty-two miles an hour on a straight and level track. The cars will work from a trolley line fed at 3300 volts reduced from a primary pressure of 16,500 volts. There are to be six sub-stations, about ten miles apart.

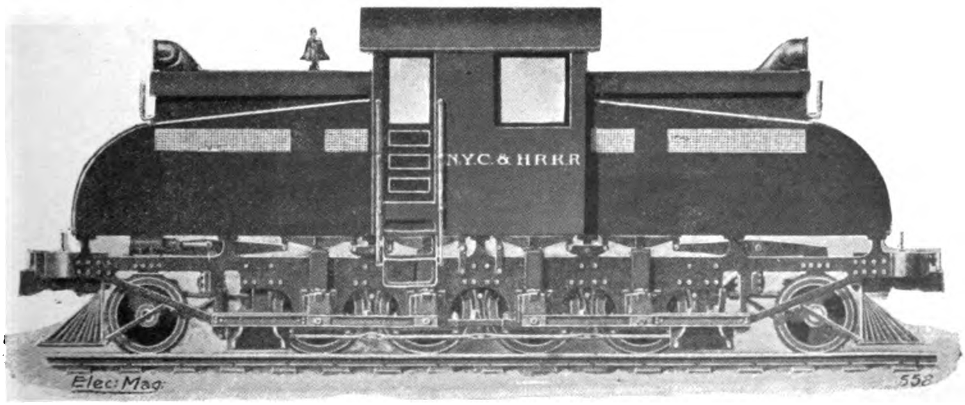
The power will be supplied by two 500-k.w., 3-phase, 25-period, 2300-volt generators which had previously been installed. The pressure will be raised at the power house to 16,500 volts, being transformed from 3-phase to 2-phase by the Scott method. The cars will run both on the 1-phase line, as well as over the Indianapolis City Railway which is equipped for 550 volts direct-current. In order to facilitate the passage from one line to the other, it has been decided to equip these ten cars with resistance control instead of back e.m.f. control.

The Westinghouse Company also informs the writer that amongst other contracts it is supplying the Swedish State Railway with a 1-phase locomotive equipped with two 150-h.p. motors and accessories, the weight of the whole locomotive being about twenty-five British tons, and the weight of each motor with its gears, gear case, and axle bearings, being 2¼ tons.

The British Westinghouse Company is now equipping an experimental line at Trafford Park on which the voltage will be 3000 and we shall therefore soon have an opportunity of seeing the Company's 1-phase apparatus at work in this country.

The company is to be congratulated on having taken such practical steps to demonstrate the suitability of this system for practical railway work.

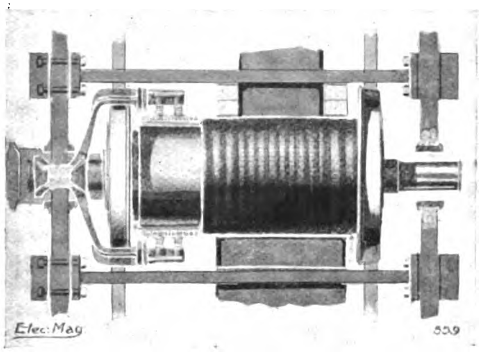
(To be concluded.)



Electric Locomotive for New York Central. (*See page* 44.)

NEW YORK CENTRAL LOCOMOTIVES.

THE New York Central Railway has adopted a type of locomotive differing in almost every respect from anything yet put on the road. The motors are bipolar gearless, the magnetic circuit, field windings, and motor poles being integral with the locomotive frame. The pole faces are laminated, and vertically tangential to the armature, thus providing for vertical movement of the frame with attached poles without affecting the air gap. The armature is built on a quill, pressed solidly to the axle. The weight of the entire rotating part, armature, axle, and wheels, is less than that of any steam locomotive, but there being no comsated reciprocating parts, there is a perfect rotative balance. We depict herewith a side-elevation (p. 43) of the complete lccomotive, and also a plan of the armature in position on the loco-



PLAN SHOWING ARMATURE OF GEARLESS MOTOR.

motive frame. In asking tenders for the locomotives the Commission stated definite conditions to be complied with. These were: that two regular successive trips of one hour each between the Grand Central Station and Croton with a total train-weight of 550 tons should be made with a single stop in each direction and a lay-over not exceeding twenty minutes. A similar schedule was also to be maintained with lighter trains and more frequent stops. Finally, the total train-weight of 435 tons should be hauled between the two places mentioned above without stopping, in forty-four minutes. With one hour lay-over this service to be kept up continuously. The contracts for the locomotives were placed with the General Electric Company in conjunction with the American Locomotive Company, these being the successful tenderers. Direct current has been chosen, as its chief features in railway operation are now well known. The locomotive is 37 ft. long over all. The wheel-base comprises four pairs of motor wheels and two pony-truck wheels, the total wheel-base being 27 ft. The driving-wheels are 44 in. diameter and the truck wheels 36 in., the driving-axles being 8½ in. diameter. The locomotive is a double-ender, and will weigh approximately 190,000 lbs. Four 600-volt direct-current gearless motors, each of 550 h.p., will furnish the requisite motive power. The armature core is of the ironclad type, and the windings of the series drumbarrel type. The conductors are designed to avoid eddy currents, and are soldered direct into the commutator segments. The brush-holders are of cast bronze mounted on insulated supports attached to the spring saddle over the journal, and maintain a fixed position in relation to the commutator. The magnetic circuits are completed through the side- and end-frames, and the pole pieces are cast in the end-frames. The armature is free to move between the pole-pieces with ampleclearance, and it will not strike the pole-pieces even if the springs are broken. The field coils are of copper ribbon, wound on metal spools bolted to the pole-pieces. The Sprague General Electric Company's multiple unit system of control is employed, there being two master-controllers in the cab, placed so that the operating engineer looking ahead will always have one under his hand. Two or three locomotives can be coupled together if required. Should the coupled locomotives become separated the control current will be automatically cut off. The total weight resting upon each of the driving wheels will be about 17,000 lbs.

Electric v. Compressed Air Locomotives for Mining.

ELECTRICITY is rapidly taking the place of compressed air, and compressed-air men are proportionally annoyed at it; and the present paper, before the Institute of Mining Engineers, coming from America, was an attempt to show that electric locomotives were more expensive than compressed-air locomotives. The author of the paper, Mr. Beverley Randolph, unfortunately for his subject, was not very well posted on the electrical side of the question. He stated that compressed air was more economical at a distance than electricity, and produced as his evidence of this the fact that while the cost of cables increased as the square of the distance, the cost of pipes only increased as the simple distance. It was at once pointed out, in the discussion, that this was a very inaccurate way of looking at the matter from the electrical point of view, and that it was only correct if the pressure and losses in the cables remained constant, and that the statement with reference to pipes for compressed air was also incorrect, inasmuch as if the pressure and losses in the pipes remained constant the cost of the pipes would also have to increase almost as the square. Double the length of pipes would give double the loss, unless the diameter of t .e pipes was increased. It was also pointed out that the two main reasons why compressed air cannot compete with electricity for power transmission were the losses by leakage from the pipes, which is very heavy indeed, and the fact that the air cannot be used expansively. If high pressures can be employed, and if the air can be used expansively, as steam is, compressed air should have a very good chance in coal-mining work because of its greater safety. The author gave some figures showing the relative cost of fitting up a system of electric locomotives for a coal-mine, and of compressed air for the same work. His figures showed that the electrical apparatus was cheaper, but he proceeded to rearrange the figures, and to explain that if considered in a particular way, the compressed-air apparatus was cheaper.

Readers are referred to the World's Electrical Literature Section at end of Magazine for titles of all important articles of the month relating to Lighting and Heating.

The Electrical Equipment of a Modern Theatre.

By the ASSOCIATE EDITOR.

THE introduction of electricity both for the lighting and mechanical effects in modern theatres has proceeded apace, and there are many notable examples of such installations on an elaborate scale. In Germany especially much has been done, and we present our readers with some account of the Prinzregenten Theatre, Munich, and its electrical equipment, to illustrate the magnificent lines on which a theatre installation can be planned and executed. The theatre is modelled on the lines laid down by Richard Wagner for his Festival Theatre in Bayreuth, and was built twenty-five years after the erection of the latter structure. The most modern improvements have been introduced into the construction of the building, and also with the electric lighting arrangements, which we purpose to describe herewith. The details of the stage and its arrangements make interesting reading, but cannot be referred to here. The fire precautions are most elaborate, and were found on test to be completely satisfactory. A water-supply line surrounds the building, there being five hydrants outside, nineteen on the stage, four in the auditorium, and eight on the various floors.

Energy for lighting and power is obtained from the Munich supply station, and is transmitted at 5000 volts, 3 phase, 100 periods, and transformed by motor generators of 125 kw. capacity to direct current at 250 volts. Two storage batteries each of 132 cells and a total capacity of 855 kw. hours are installed. Distribution is on the three-wire system, 220 volts between the outers. The neutral is bare, but the other leads are insulated and steel armoured. Five main circuits feed the stage, auditorium, restaurant, and stage and auditorium motors and effect lamps. The four-colour lighting system has been adopted for the stage, white, red, green, and yellow. Special regulators are provided whereby the sets of lamps may be dimmed or brightened at will; as green and yellow are never used together one regulator is employed for both colours. The regulators comprise twenty-three rheostats and switches on one shaft, so that separate groups may be operated or all groups together, the latter being effected by a handwheel moving all the rheostats simultaneously. Small cables and wires are insulated in each case and all lamps are protected with fireproof material. Fig. 1 illustrates a portion of a batten, in which the lamps, reflectors, and wire netting can be seen. Fig. 2 explains the wiring for the colour lamps, the lamp mounting and porcelain duct for leads being clearly shown. There is a common wire under-

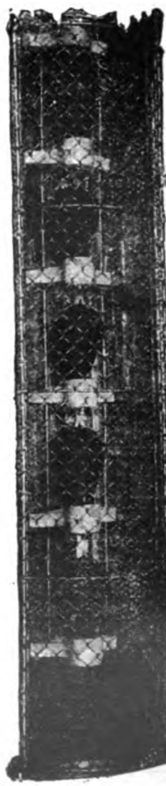
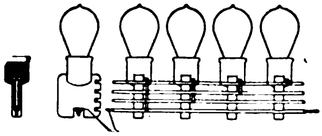


FIG. 1. PROTECTED ROW OF INCANDESCENT LAMPS.

Fig. 2. Arrangement of Colour Lamps with Common Return.



neath the porcelain, which is the return for the various colour leads. Movable footlights and reflectors are coupled to the circuits by flexible leads and plugs inserted through traps in the stage, into special four-wire sockets, as shown in Fig. 3. There are forty-four floor boxes for the three-colour system on the stage, and two on each side on the gallery in the wings.

Fifty plug receptacles are filled for the effect lamps which are operated on the Lantenschläger system. Six lamps have hand regulators, German silver reflectors, and colour screens. Six others act as reflectors for throwing a very intense light and have plano-convex lenses, in addition to which there are scenic effect slides for clouds, rain, snow, rising moon, &c. Red signal lamps are placed below the stage to give instructions for the movement of scenery, thunder, and lightning, &c., the signals being under the control of either the orchestra, prompter, stage-manager, or his assistant. The orchestra lighting is on alternate circuits which prevents the total extinction of the lights should one circuit fail.

In the auditorium there are fourteen arc lamps (Fig. 4) and fifty incandescents in the boxes, having a separate regulator. The arcs are switched on in pairs or all together, and these are hung from the ceiling and covered with crystal globes. They are lowered to the floor for trimming. The cloak-rooms and promenade are lighted from two circuits, as a prevention against breakdown, and the foyer, stairway, entrance hall and imperial suite are also lighted by incandescents. The vestibule and main entrance are lighted by arc lamps. The distribution of the lamps through the building is indicated by the following table:

	Incandescent Lighting.	Arc Lamps (Effect).
Stage lighting	2312	12
Dressing and Green Rooms	173	—
Orchestra	72	—
Auditorium	50	14
Cloak Rooms	630	8
Restaurant	201	8
	3438	42

For lighting the stage during rehearsals twelve separate thirty-two candle-power lamps are used.

A five horse-power motor on the second gallery over the stage drives a special shafting used for moving machinery. A motor on the right of the stage raises and lowers the prospective and by a special device can raise one while lowering another. An electrically driven fan furnishes 1,712,000 cubic ft. of fresh air per hour which when the house is full means 1178 cubic feet of air per person. A purifying chamber is inserted in the intake in which the air is warmed before delivery in the building.

The air pressure in the auditorium is arranged to be slightly higher than that of the stage, so that should delay arise in dropping the curtain in case of fire, the flames will not burst out upon the audience.

The seating capacity of the theatre comprises seventy-eight box seats and 1028 seats in the auditorium floor. As there is no balcony or gallery there is no difference in the price of seats. The electrical equipment has been entirely carried out by the Allgemeine Elektrigitäts-Gesellschaft, from plans furnished by the Imperial Machine Director, Lantenschläger. Our thanks are due to the Allgemeine Elektrigitäts-Gesellschaft for the photographs illustrating the above account. The theatre we may mention, has one of the largest stages on the Continent, nearly 100 ft. wide by 120 ft. deep, and is operated under the supervision of the Prinzregenten Opera House Co.

The Problem of Improving Electric Lamps.

There seem at the moment to be several improvements in the air, and some are becoming known in the world of commerce. It is therefore interesting to hear what Mr. H. N. Potter in the *Electrical Review*, New York, has to say on the subject of possible improvements, seeing that it is well known he is engaged in working out details of one of the new developments. With the Bremer arc lamp, which uses electrodes consisting of carbon and various calcium compounds, there are still various problems to be solved. These points relate

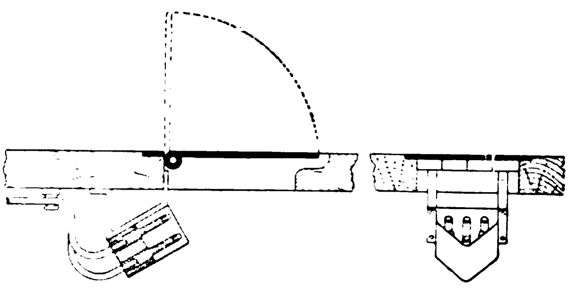


Fig. 3. Socket below Stage with Door.

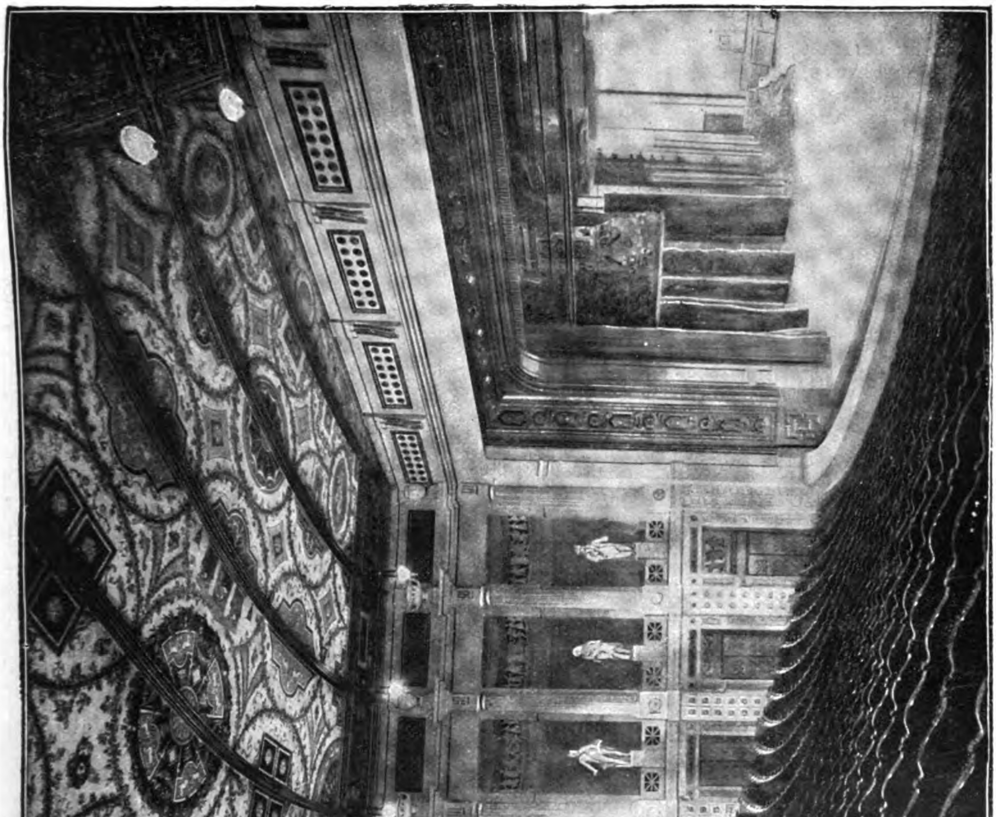
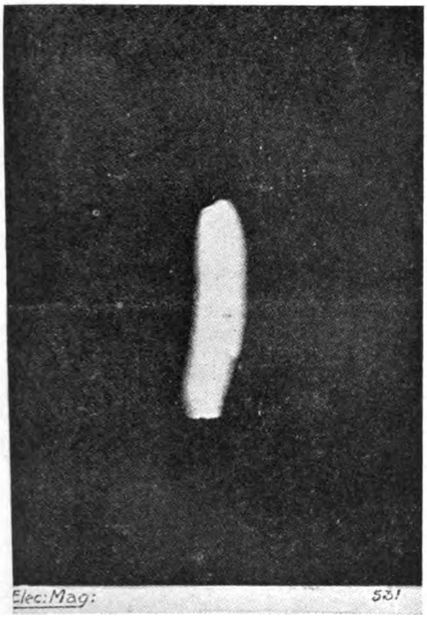


Fig. 4. Auditorium Prinzregenten Theatre, Munich.

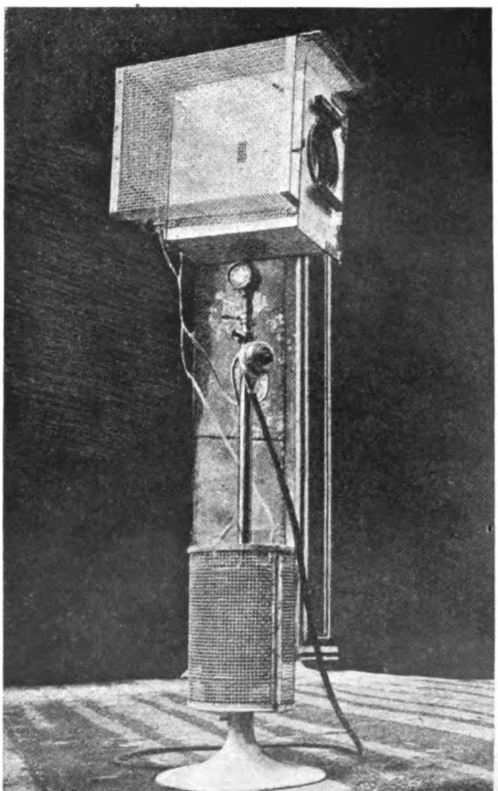
mainly to practical questions, and are not so much concerned with the idea in the abstract as with the lamp itself in the concrete. Originally, no doubt, it was imagined that an increased efficiency of luminous radiation was the main point to be insisted upon. Now it is found that this involved practical disadvantages of such a kind as to necessitate revision of first principles. The electrodes burn away too fast, the fusible slags are a nuisance, and the feeding mechanism has not been without attendant troubles. The ordinary arc lamp has no slags; the oxides of carbon are volatile; the feeding mechanism has been worked out till it has become sufficiently stable for working conditions. It seems likely that an improvement would be welcome by which the impregnating salts were so chosen that they sublime instead of forming fusible slags, even if this should result in a decreased luminous efficiency. With regard to the Cooper Hewitt lamp, it must necessarily have some sort of transparent containing vessel. Almost the only substance available is glass, which is not very refractory, but is quite sufficiently so for ordinary purposes. A limitation is to be found in the fact that the vapours of many substances, which might be used, attack glass more or less seriously; so we have to fall back on mercury with its rather unpleasant spectrum. That inventor would be welcome who could devise a method of adding red rays to the spectrum; but as his existence is believed to be impossible, details of construction seem to be the only hopeful subject for improvement. And whereas complaint is made of the nature of the light, we may congratulate ourselves on the fact that the spectrum of mercury is by no means unusually bad when compared with that of other metals, and that we may esteem ourselves fortunate in having a substance like mercury available for use under the circumstances. The Moore lamp, which has been developed out of the Geissler tube, has not altogether reached the stage of the practicable. The nature of the light is good, its colour admits of almost indefinite variation, but the size which is necessary for even a comparatively feeble light, makes it too cumbersome for ordinary use. Independently of which, there are other difficulties of a serious nature, which are likely to exclude it from practical consideration for some time to come. Mr. Potter's remarks on the Nernst lamp, coming as they do from an expert on the subject, are worthy of careful consideration. One disadvantage of this lamp is that the glower burns in air. In this way heat is radiated from the filament by means of convection currents, and the temperature therefore requires to be maintained by means of an increased amount of energy, conveyed to it by means of the current. In this respect it is at a disadvantage as compared with the incandescent lamp. On the other hand, it does not lose so much in the way of invisible radiation; and seeing that nobody wishes to heat his room by means of his electric lamp in the same way that the burner of gas often does, the amount of invisible radiation should be kept as low as possible. It is in regard to this point that the Nernst lamp claims to be an improvement over the carbon filament. The remarkable thing about this lamp, however, is that experts are not yet agreed as to whether it does better on direct or alternate current. What is more, they not only do not agree, but they disagree *in toto*. The Americans think that alternate current of increased frequency, say 250 alternations per second, or 125 complete cycles, would pay everybody, if used with Nernst lamps, in spite of the higher cost of transformers. As for using the lamp with direct current, they seem almost to leave that out of consideration. It is well known that the German manufacturers take precisely the opposite view; and it seems likely more things are known in Germany than are dreamt of in American philosophy, and *vice versa*. In fact, the Germans can make lamps for direct current, and not for alternate current; the American experience seems to be that the alternate current filament is the easier to make. There must therefore be some points of difference in the manufacture, and something which has yet to be learnt by both. The heater is a source of weakness, so to speak. Not that the heaters at present in use are not good of their kind. Considering the difficulty of constructing heaters to withstand a temperature of 1000° C., the solution of this problem must be considered quite satisfactory. But there is room for hope that they may be still further improved. Under the conditions, the platinum, which is wound spirally round the substance of the heater, is not altogether stable. A deposit of platinum black is formed on neighbouring cool surfaces, which can only emanate from the platinum spirals, thus tending to show that the heater itself is liable to a gradual disintegration. An improvement in this feature of the lamp is possible, but it is a difficult problem to tackle. If too a heater could be made which would stand a higher temperature than the present ones, it might be possible to utilise other rare earths, which are not as yet available, owing to the fact that they require too high a temperature to make them conductors, and this higher temperature cannot be reached by the present methods of heating.



VIEW OF MAGNETITE ARC.

THE MAGNETITE ARC LAMP.

MR. C. P. STEINMETZ makes a most interesting contribution to a recent number of *The Electrical World and Engineer.* He points out that the present methods of transforming electrical energy into light result in a 2 per cent. efficiency in the case of the incandescent lamp, and about 5 per cent. in the case of the arc. One of the main objections to the Bremer type of lamp is the fact that it cannot be enclosed air-tight, owing to the smoke or dust which is produced; the electrodes, therefore, burn away rapidly. In studying the problem of replacing the ordinary carbon by something more efficient, it is necessary to remember that the electrode must be formed of a substance that is a conductor, and its vapours must also be conductors; it should be incombustible, *i.e.*, it should be oxidised to the fullest extent; it should have a good spectrum, giving a white light. A long search has been made by the General Electric Company of America with a view to finding something answering these requirements, and the conclusion is now arrived at that magnetite, the black oxide of iron, is the most suitable. The investigations have shown that the positive electrode appears to get hot owing to something of the nature of a discharge, shot out from the negative pole. The impact of this on the tip of the positive electrode causes it to get hot, unless it is of sufficient size and a good conductor of heat, in which case the positive electrode is altogether unaffected. The new type of lamp, described by Mr. Steinmetz, differs therefore substantially from anything with which we are familiar, inasmuch as it has a positive electrode consisting of copper, which does not wear away, but is only allowed to get sufficiently hot to prevent the deposition of anything on it which may be shot out from the negative pole. The light-giving substance is a column of magnetite vapour, the lower electrode being formed of magnetite, which is a well-known ore of iron, very plentiful in nature, stable at all temperatures, and gives a good white light. The efficiency of magnetite is said to be about twice that of carbon, but it burns away comparatively fast, at the rate of about one-eighth of an inch per hour. Flame-arcs of the Bremer type burn away at the rate of one or two inches per hour, so that the magnetite lamp improves on this figure. Various substances, such as titanium compounds, and other salts or oxides not specified, are added to the magnetite electrodes, for various purposes, notably for increasing the life of the electrodes. Thus, without any loss of efficiency, by judicious blending, it is said to be possible to produce a material which burns away at the rate of one inch in from twenty to thirty hours; and by slightly sacrificing the efficiency, a life of from five hundred to six hundred hours can be obtained for an eight-inch electrode. The feeding mechanism is also a novel feature. The electrodes are separated in the first instance by a certain distance, which is about seven-eighths of an inch. The lamp burns until the distance has increased to such an extent as to raise the voltage sufficiently to bring the feeding mechanism into play, when the



IMPROVED STAGE ARC LAMP.
(see page 50)

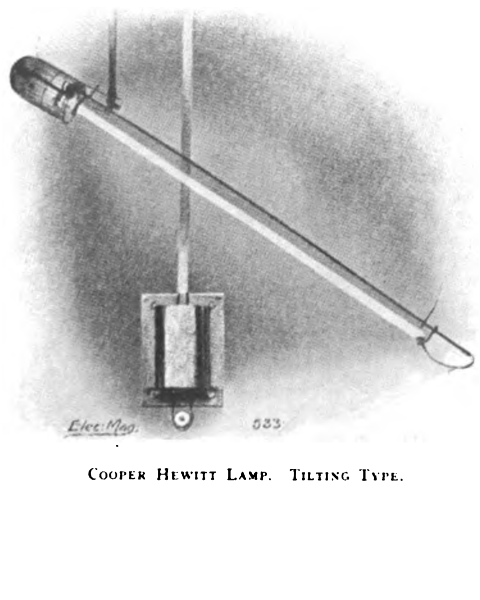
electrodes are brought back into their original position, in so far as their distance apart is concerned. Altogether this lamp appears to be a striking novelty, and judging from the rough outline of it given in the article mentioned above, it looks as though it were likely to inaugurate an entirely new departure in the design and construction of arc lamps.

THEATRE LIGHTING BY ELECTRICITY.

SINCE the lamentable fire at the Iroquois Theatre at Chicago, all the theatres have been overhauled, and all were closed for six weeks after the fire for this purpose. Our illustration (p. 49) (from the *Western Electrician*) shows the type of projector that has been sanctioned by the city authorities, and is considered absolutely safe for the purpose to which it is intended that it should be applied. The base is of aluminium for the purpose of lightness, and contains the resistance coil. The coil itself is wound with asbestos-covered wire, and is enclosed in a netting of steel wire. The arc lamp is carried above on the upper part of the structure. It is contained in a galvanised-iron box, which is itself enclosed in a casing of wire netting. There is an opening in front of five inches diameter, through which the light is emitted, the lamp being intended to be used in the gallery for the illumination of the stage. A large number of special safety devices are employed in the different theatres in Chicago as a result of increased vigilance on the part of the authorities, and the regulations have been made more stringent in matters of detail. The projector-lamp, illustrated herewith, may be taken as a type of the improvements that are being effected.

LIGHTING BY COOPER HEWITT LAMPS.

WE give herewith an illustration showing the effect produced by Cooper Hewitt lamps in lighting large spaces. The starting of the lamp is effected by the tilting method, which



COOPER HEWITT LAMP. TILTING TYPE.

ACCUMULATOR STORE LIGHTED BY COOPER HEWITT LAMPS.

is simple and effective, and seems to be found better than the use of a make-and-break coil. The room shown in the photograph is used by the New York Transportation Company for housing their accumulators. It is 300 ft. long, 42 ft. wide, and 26 ft. high. Formerly it was lighted by fourteen arc lamps, taking 5 amperes each at 115 volts. But the vapours arising in the battery-room were found to be very prejudicial to the mechanism of the lamps, and after many difficulties and experiments it was determined to try the effect of the Cooper Hewitt lamp. Accordingly, ten of these lamps were put in, each taking 3 amperes, and this has been found to be amply sufficient for the purpose. The illumination, as shown in the illustration, is very evenly diffused, without shadows of any kind, and has the general effect of daylight. The current consumption has, moreover, been reduced to one-half of what it was before, when arc lamps were used. The mercury lamp is beginning to be more generally employed in lighting of this description, and is suitable for use in factories and offices, where the colour of the light is of no consideration, and where the illumination is required to be of a steady character, suitable for ordinary commercial purposes.

LIGHTING AND HEATING NOTES.

Lighting of the St. Louis Exhibition.

THIS exhibition will afford, as is usual in the case of large shows of this kind, a striking object-lesson in the art of designing illumination on a big scale. The power plant required will be sufficient for the lighting of many a full-sized town. The power-house will contain four units, each of 2800 h.p., and the plant which is being shown by exhibitors will also be called upon to furnish current. The largest unit on show is one of 5000 h.p. In addition to all this, arrangements have been made with the Union Light and Power Company of St. Louis to supply, when needed, a further 7500 kw. The arc lights are to be run in series on a 3500-volt circuit at fifty cycles. Nernst lamps are to be used to light the Fine Art Gallery. Altogether there will be 1541 Nernst lamps, taking 401 kw. From this it can be seen that the whole has been worked out on the largest scale, as befits an Exhibition which is intended to outdo all its predecessors.

For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section at end of Magazine.

The Lorimer Machine Telephone System.

In an Editorial Note last month we made a few remarks on automatic telephony, and announced our intention of giving illustrated details of a new American system. This system is an invention of Mr. G. W. Lorimer, and is under exploitation in Canada and the United States, though we understand an exhibition exchange will shortly be on view in London. Those of our telephone readers interested in automatic telephony, will doubtless inspect the Exchange when on view, but meantime we can give them some account of what is an extremely interesting method of obviating manual operation. The principle is based on the *percentage* of subscribers using the lines and no more apparatus is provided than will deal with this percentage, which is predetermined. From experience 20 per cent. (10 per cent. talking to 10 per cent.) of the total subscribers may be taken as a fair average. The exchange mechanism is made common to all subscribers, and by using constantly revolving parts, presented in succession to all the incoming lines, this small percentage of apparatus is enabled to do the work of 100 per cent. under existing manual and other automatic systems. It seems unreasonable that apparatus should be provided for each subscriber when a percentage of the whole can do the work. To describe the system in detail would take us beyond the limits of our space but exchange managers requiring full particulars should apply for the company's exhaustive pamphlet on the system. We can only briefly indicate the chief instruments and apparatus used touching lightly upon their functions.

Fig. 1 depicts the subscribers' instrument which in addition to the ordinary receiver,

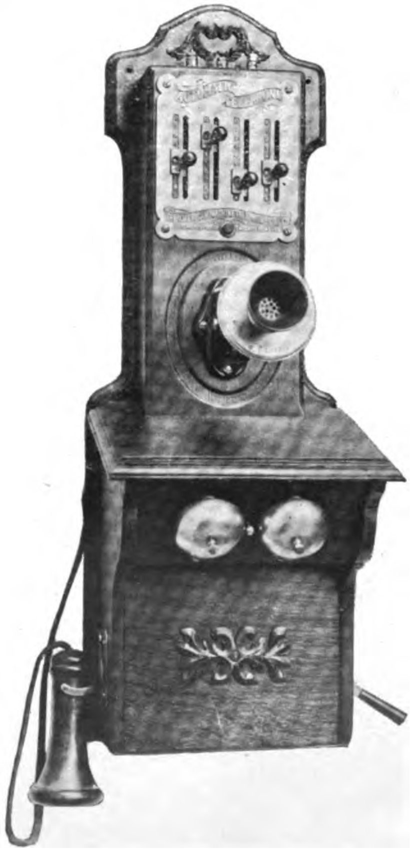


FIG. 1. SUBSCRIBERS' STATION.

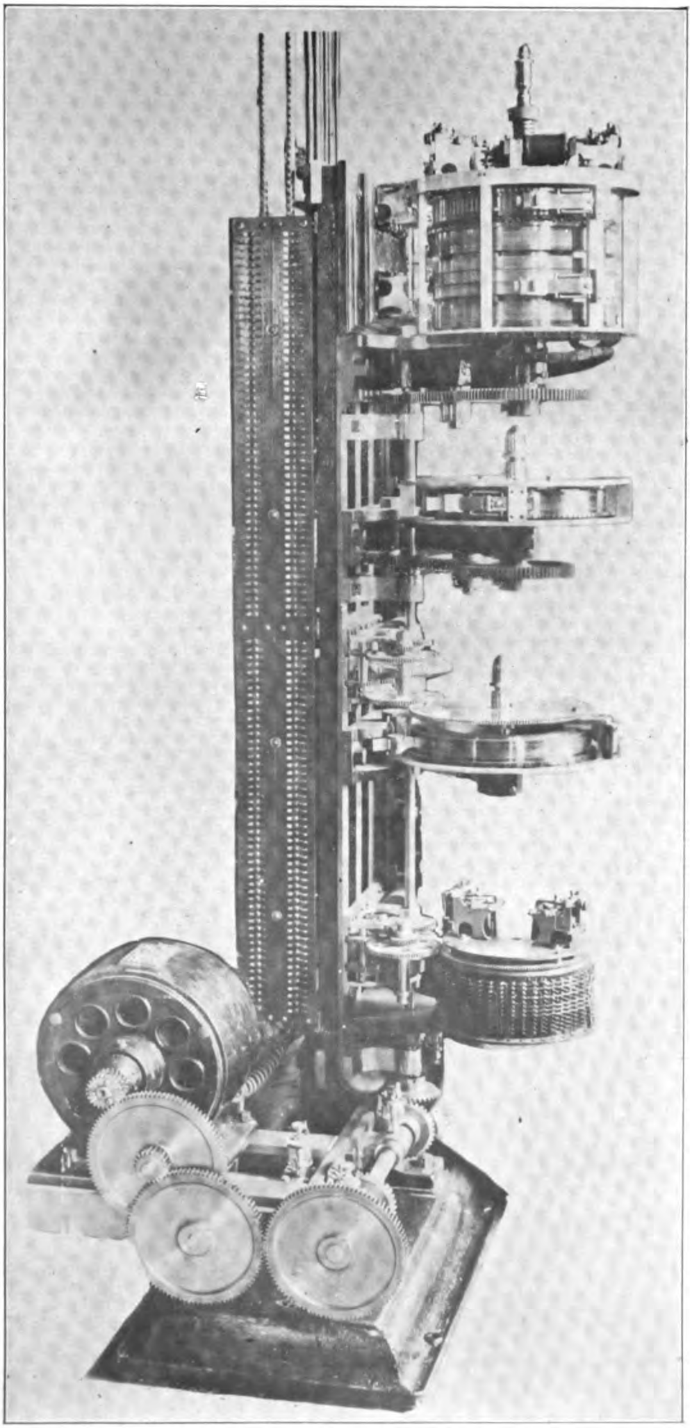


Fig. 2. Sectional Division.

transmitter, and call-bell, consists of an impulse generator adapted to transmit signals to the central in series or sets, with means for varying these signals at the subscribers' pleasure. A lever projecting from the box (on the right) serves the purpose of setting these impulses in motion, there being a clockwork train and contact wheels operated by the lever when depressed. Above the transmitter are four indicator switches, each comprising a row of numerals from 0 to 9, and a sliding knob for setting to the required number. Manipulation of these switches gives any desired number combination from 0 to 9999. The impulses sent from the subscribers' station set in motion exchange mechanism which selects the required line, calls, and puts through the subscriber wanted. If engaged a "busy" signal is given. After use the line is automatically cleared and the apparatus set at once for the next call.

At the exchange *there is no individual apparatus*, the percentage system being employed. The exchange is composed of units or sections, each a complete exchange for one hundred subscribers, and capable of being added to as required. All section connections are made at the factory, couplings *between* sections and the line terminal board being those only necessary. This is a most valuable feature of the system. Each section comprises eleven parts, or "divisions," one sectional and ten percentage divisions. The former is common to all stations of the sections, and is used to transfer the subscriber to the connecting apparatus, being in use but a short time. The sectional division (Fig. 2) is made up of

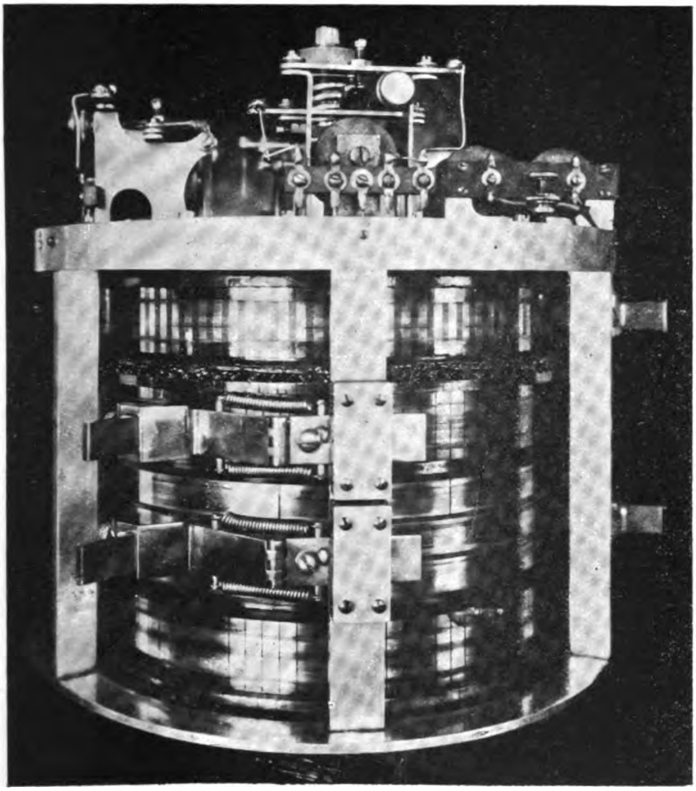


FIG. 3. DECIMAL INDICATOR.

(1) The Decimal Indicator.
(2) Division starter.
(3) Decimal Register Controller.

The decimal indicator (Fig. 3) tests all section lines for calls, selects an idle division, and in combination with the last two parts of the sectional division forms the calling circuits. It also tests all lines for grounds every four seconds, and troubles from this quarter are announced on a gong. A "guard" potential is also introduced by it to prevent interruption of the conversation. The division starter brings one of the percentage divisions into operation for the calling and called subscribers. The decimal register controller registers on the decimal register the tens value of the calling line.

The Percentage Division (Fig. 4) is made up of primary connector with decimal register, rotary switch, signal transmitter, controller interconnector, secondary connector, two signal registers, and signal, ringing and release relays. The primary connector closes the calling and speaking circuits when the required connection is made. The rotary switch is a moving device bridging the contacts of fixed brushes and closing circuits of the different pieces of control mechanism. The signal transmitter controller transmits impulses over the line, calling the subscriber, forming part of the talking and ringing circuits after sending these impulses. The interconnector determines the section of the exchange on which the number required is to be found and also selects an idle secondary connector in this section. The secondary connector depends upon the co-ordination of movement of the above two switches determining the line wanted; one is the tens register, finding the group of contacts wanted and the other is the cylinder switch finding the individual contacts in each group. It bears the same relation to the called line as the primary connector does to the calling line.

The signal registers register the numerical value of the different sets of impulses sent from the calling substation. Of the relays the signal relay controls the signals from the

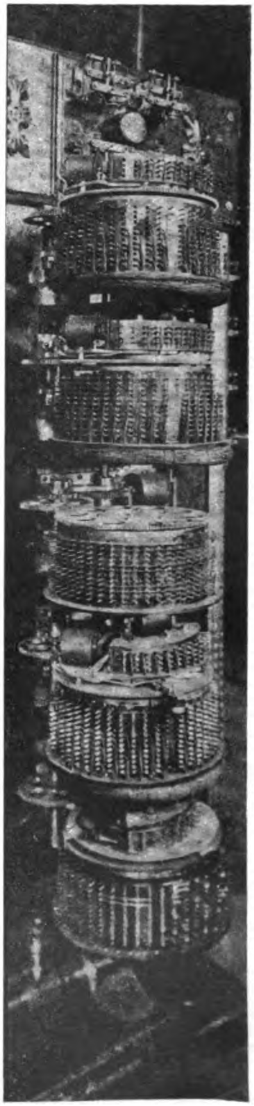


FIG. 4. PERCENTAGE DIVISION.

signal transmitter controller to the different signal registers, the ringing relay introduces the magneto current over the calling line, and the release relay restores the whole percentage division apparatus to its normal position.

The hanging up of the receiver at the subscribers' station energises the operating circuit, and the relayed circuit acting directly on the rotary switch starting the brushes of the same from the talking to their normal positions, thereby restoring all the other apparatus to its normal position. We shall refer to this interesting system as occasion arises in future issues. Meantime we may reiterate in conclusion some of its few advantages. Low cost of installation, operation, and maintenance; perfect privacy; rapid connections (average fourteen seconds); cheapness of extensions, uninterrupted day and night service, positive contacts. In addition, the common battery is used throughout, and in every case the clearing-out mechanism acts promptly. Another call can be initiated at once after replacing the receiver on the hook; taking one-fourth the time for consecutive calls permissible by the manual system. The apparatus is much more simple in construction than the description above would indicate.

THE TELEGRAPHONE.

As promised in our last issue, we herewith present our readers with an illustrated account of Valdemar Poulsen's latest type of telegraphone. Since its introduction in 1901, when it very strongly resembled the phonograph in design, it has been considerably improved, and in its present form may well find a place in any modern commercial establishment. It can be used for a variety of purposes with no other adjustment than the mere turning of a small switch provided at the front of the instrument. It will re-

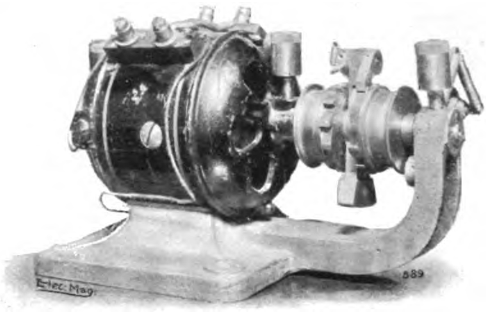


Fig. 2. The Telegraphone Motor.

cord and reproduce sound in a similar way to the phonograph, although it does not return the sound with the same volume as that instrument —in fact, two telephone receivers are required for hearing the reproduction. It can be placed in circuit with the telephone, and will then record, in the subscriber's absence, any conversation taking place, automatic switches being provided for starting and stopping. It will serve a special purpose for the dictation of letters, and can be used in this way without transportation from one office to another, as insulated wires place the typist in communication with the instrument.

Our readers will doubtless remember that the principle of the instrument depends upon a variation in magnetism set up in either an iron-ribbon, wire or disc, by a small electro-magnet placed in circuit with a microphone and battery. This magnet presses on the wire tape or disc, and exactly as variations in its magnetism are set up by the impulses in the circuit induced by sound-waves in the microphone, so are these magnetic changes recorded on the receiving medium. If the machine is run back, and the wire permitted to run over the magnet which originally recorded the sound-waves, these records will set up magnetic variations in the electro-magnet, which, corresponding as they do to the original sound-waves, will result in the reproduction of these sounds in the telephone receivers. If subjected to the action of a permanent or electro-magnet the wire will be "cleaned" of its records, and ready

Fig. 1. Latest Type of Telegraphone with Accessories.

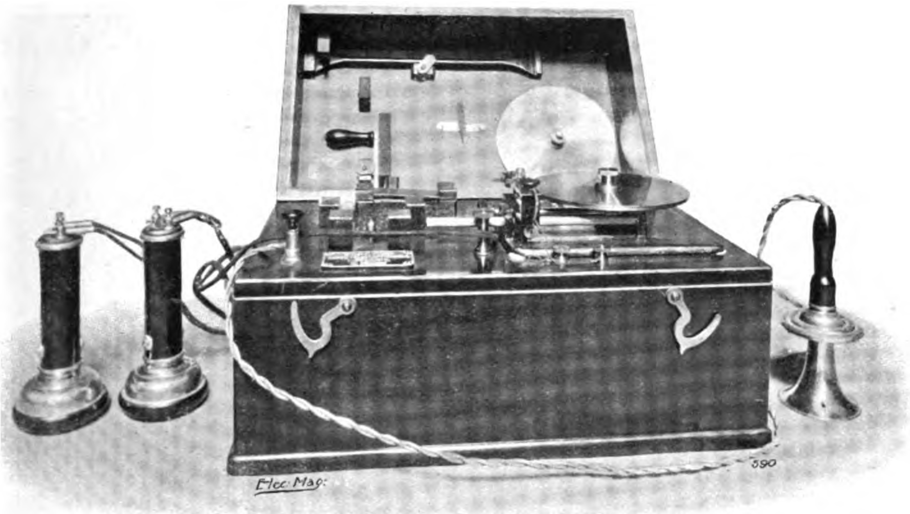


FIG. 3. CLOCKWORK TELEGRAPHONE.

to receive others as required. There is no wear of the wire and the record once made is permanent.

Fig. 1 depicts the latest type of instrument. It will be seen that this comprises a box, on the top of which are mounted two drums. These contain the recording wire, and are driven by a small motor (Fig. 2) in the body of the box through suitable gearing and belts. Placed centrally between the drums is a movable arm fitted with the recording and obliterating magnets. The wire passes through sapphire bushings in the special carrier at the top of the arm, and passes over the magnets as before-mentioned. Directly below the lid, at the front of the box, is a pointer indicating the length of wire run off and the position of starting and stopping. Lower down to the right-centre of the box is a switch, which serves to change the various circuits of the recording and speaking battery. By this switch the instrument can also be put in circuit with the telephone for automatically recording messages. To the right of the box, lying on the table, can be seen the microphone transmitter, while on the left are the receiving telephones, and also a

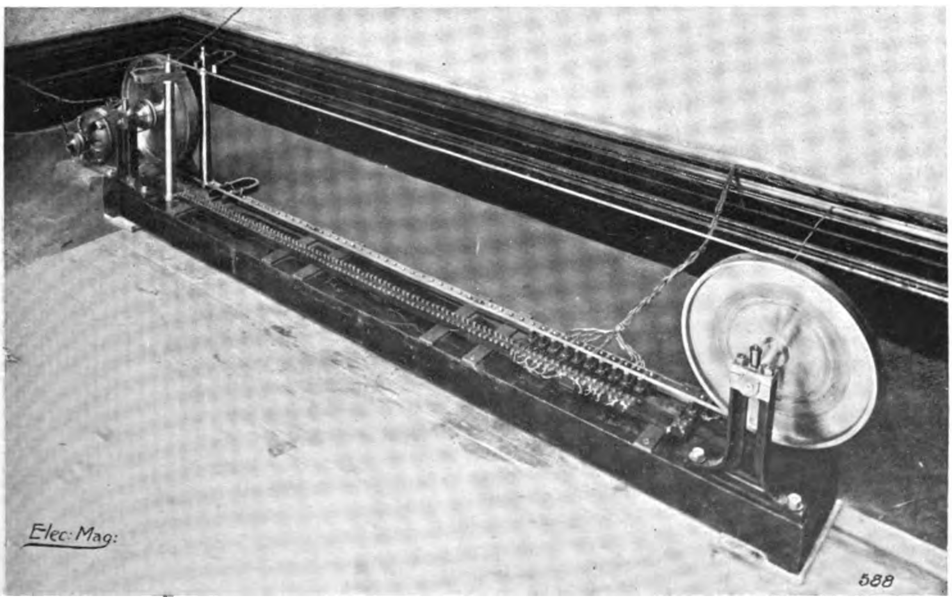


FIG. 4. TELEGRAPHONE ARRANGED FOR DISTRIBUTING INFORMATION.

special headpiece for the use of the typist when receiving letters dictated into the machine. The small switch-box, with three push-buttons protruding, is for use in starting and stopping the machine. The wire runs at a speed of about 7 ft. per second, and as it is reeled from one drum to the other the carrier with its magnets is moved backwards and forwards in accordance with the position of the wire as it is unwound. In speaking, the switch is so placed that the obliterating-magnet is in circuit and the wire is thus automatically "cleaned" before it reaches the recording-magnet, some one or two inches in front of it. By an adjustment of the switch the obliterating-magnet can be cut out of circuit and the record will remain on the wire as long as required. When used for dictating, in stopping the machine a special contrivance is fitted, whereby it reverses several feet of wire, and thereby enables the typist to take up the end of the last sentence before proceeding with the next. This reeling back is effected without the movement of any additional switches other than that used for stopping.

The sounds reproduced as heard in the receiving telephones are exceptionally clear and free from scrape, and even the faintest sounds are distinctly reproduced. We understand that experiments are in progress for the accentuation of the sound to permit of its reproduction in volume from the mouth of a trumpet. When used for dictating, the machine is placed on an office desk, and a microphone transmitter and receiving telephones, with starting and stopping-switch, only are required. In the typist's room the headpiece and starting and stopping-switch only are provided, the machine itself remaining in the principal's office. By sounding an electric bell the typist is notified that the letters are ready, and can be proceeded with. The headpiece is then placed in position, and the machine started and stopped as required as the letters are written.

Fig. 3 indicates an instrument with a clockwork motor and device for recording sounds on a small disc. Both sides of this disc can be used, and it can be sent by post without fear of injury. The obliteration of the sounds in this case is effected by making several radial strokes with a permanent magnet on the disc. Fig. 4 depicts the telegraphone as adapted for distributing information. In this case an endless steel-tape is arranged to run over pulley-wheels placed at suitable distances according to the number of transmitting stations connected. On the baseboard to the left of the right-hand pulley-wheel will be noticed a small magnet. This is in the recording circuit, and "delivers up its message" magnetically to the tape. This is driven forward by a small motor and passes over the number of receiving-magnets connected to receiving stations, which may be at any reasonable distance, and at the ends of which telephone receivers are fitted. The tape, in moving forward, has an identical influence in the transmission of a message upon each receiving-magnet placed in its path. After passing the last magnet the tape is submitted to the usual process of cleaning by its movement under and over permanent magnets. The same steel-band serves the purposes in its revolution of recording whatever message may be required, and of transmitting it to any number of receiving stations without external adjustment of any kind. The instruments are being put on the British market by a syndicate (28 St. Swithins Lane, E.C.), and from our recent inspection we cannot speak too highly of their design and finish, while the claims of the inventor are fully borne out. It will be interesting to record the influence which this instrument may have on commercial affairs.

NEW HOLBORN CENTRAL BATTERY EXCHANGE.

The National Telephone Co.'s new Exchange in Birkbeck Buildings, Holborn, was opened on May 11th to replace the Exchange formerly in the building at the corner of St. Andrew Street and Holborn Circus. The new switchboard is at present fitted for 4600 direct subscribers' lines and is designed for an ultimate capacity of 8700 direct lines.

The central battery system is used, the essential feature of which is that all the power required for working lamp signals, operators' and subscribers' transmitters and subscribers' bells, is supplied from a power-plant and large storage battery at the Exchange. Subscribers' calls are notified to the operator by miniature lamps, one, together with a "jack," being attached to the exchange-end of each subscriber's circuit. When a subscriber removes the telephone from its rest, the signal lamp corresponding to the "jack" and number glows, and on the operator plugging into the "jack" to answer the call, the glow-lamp is automatically extinguished.

The plugs and cords (Fig. 1) used to answer calls and establish the required connections have two lamps attached to their circuits, and these are so arranged that when the subscribers' telephones are off their rests the lamps remain

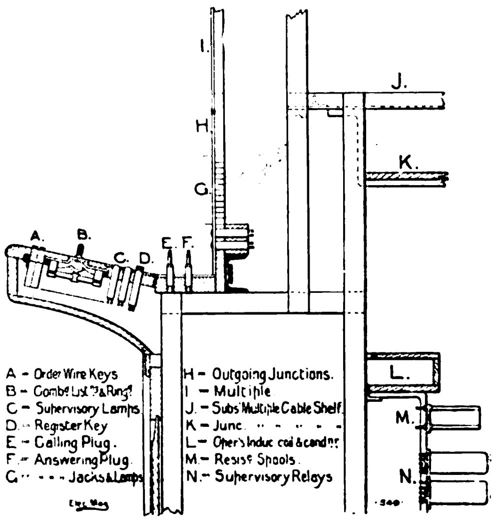
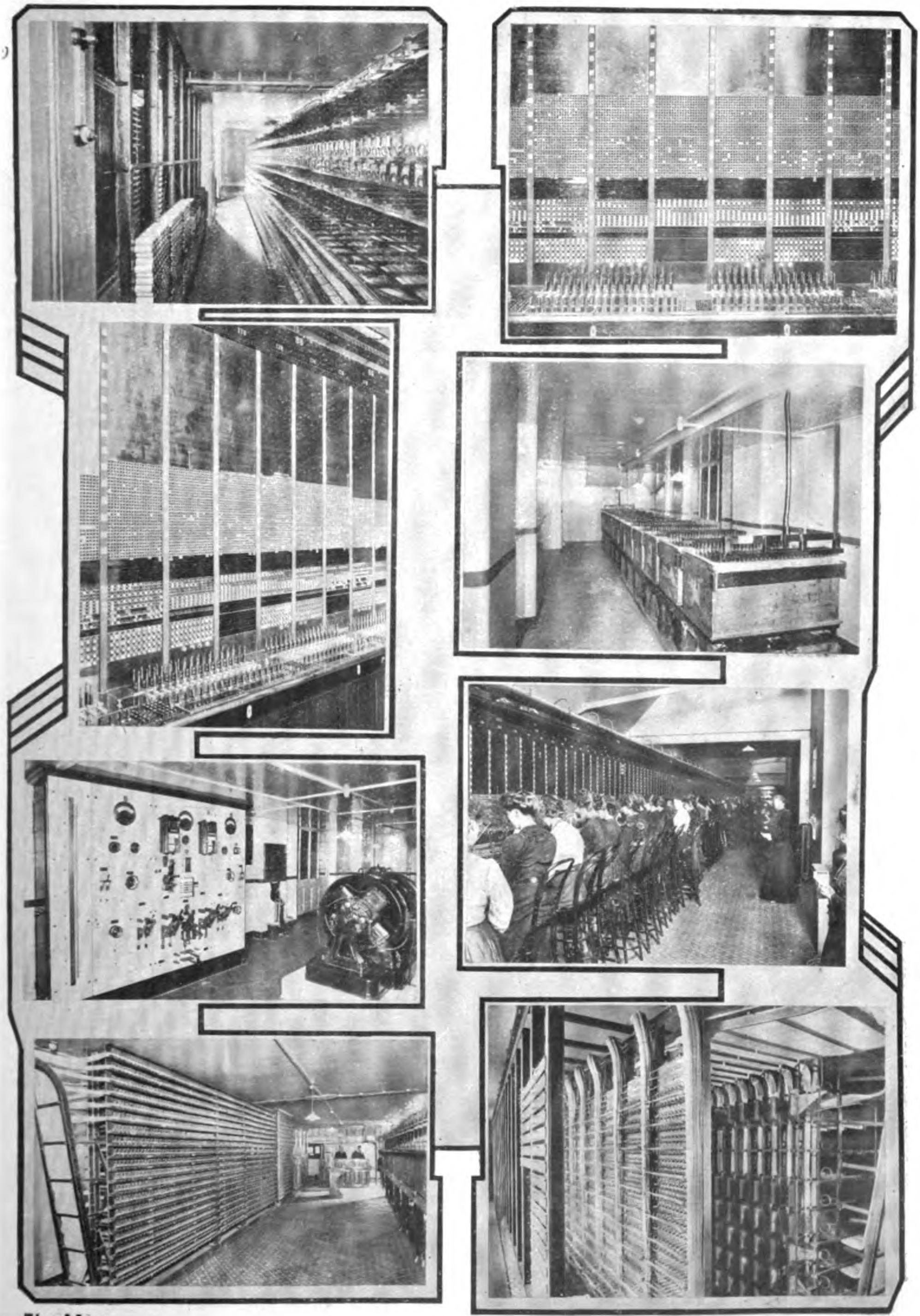


FIG. 1. SECTION THROUGH OPERATING BOARD.



Elec.Mag 569

National Telephone Company's New Holborn Exchange.

(Views of Exchange and Accessory Plant.)

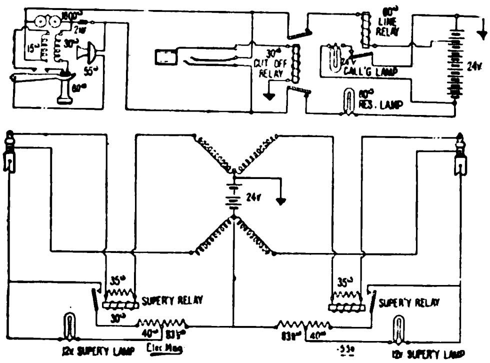


FIG. 2. DIAGRAM OF CORD CIRCUITS.

dark. Should one or both subscribers replace their telephones, the corresponding lamp or lamps glow. When both lamps glow this constitutes the signal to disconnect the two lines, and on the withdrawal of the plugs the two lamps are automatically extinguished.

In addition to the subscribers' and "ring off" lamps, each operator's position is fitted with four special lamps, viz., "pilot," "green," "red," and "register." The pilot lamp lights when a subscriber's lamp glows. This enables the supervisors to check the work of the operators. The green lamp lights when a monitor or the manager connects to the "instruction circuit," for the purpose of eliciting information simultaneously from all the operators, or when it is necessary to trace a particular call. To answer the green lamp, each operator depresses a special key and listens to the inquiry. If the inquiry does not concern her, she releases the key and the lamp is automatically extinguished, thus enabling the supervisors to check whether all the operators have attended to the "instruction circuit" call.

A red lamp lights when a connection is made to a subscriber on an Outer London Exchange by means of a junction, and is to remind the operator that the special register key must be pressed twice to register 2*d*. instead of 1*d*. This lamp is actuated by means of an additional contact on the key of the Outer London Exchange junction circuits.

The register lamp lights to show the operator when the subscriber's register has responded to the pressure of the register key which corresponds to the plugs used to establish connection. Toll subscribers' calls are compiled from their

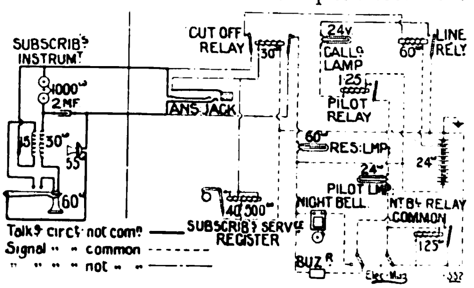


FIG. 3. SUBSCRIBERS' LINE DIAGRAM.

"registers" or "meters," and the calls on the registers of subscribers on the unlimited rate are neglected except for the purpose of ascertaining the total number of calls made on the Exchange. Night calls, in addition to actuating the subscribers' glow-lamp, night bell, and pilot lamp, actuate the ordinary lamp used for lighting the room at that particular part of the switchroom.

The manager's and monitor's desks are fitted with lamps and switches which enable the operators to be supervised from these points and also special inquiries to be dealt with.

The new switchroom is 223 ft. long, and is served at the present time by ninety-nine operators. When 5600 direct subscribers' lines are completed the board will contain 827,894 working contacts, 1,169,000 soldered connections and 2900 miles of wire in cables, sufficient, if extended, to reach two-thirds of the distance between London and Chicago.

The power-plant consists of two ·12 kw. motor-generators, supplied from the Charing Cross Co.'s mains, taking 200 volts and generating 30 volts for charging the storage battery of 11-51 plate chloride cells. For the ringing circuits and "engaged" signals, two 150-watt

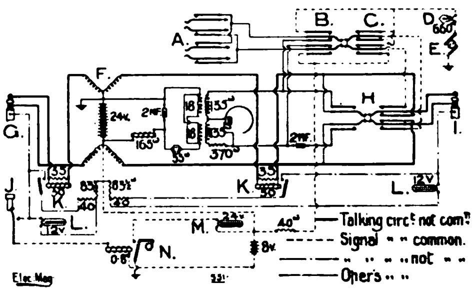


FIG. 4. LINE DIAGRAM.

motor generators are employed. To enable the subscribers' circuits to be changed over at a given instant from the old to the new exchange situated apart at a distance of over a quarter of a mile, all the subscribers' lines on the old exchange had to be tapped on to the new switchboard; all the lines for a time thus being connected to both boards. At an appointed time the service ceased at the old exchange and was taken up at the new. The lines were then gradually disconnected from the old exchange and the connections to the new made permanent.

The entire equipment for the Exchange was supplied by the Western Electric Co., of London and Chicago.

Figs. 2, 3, and 4 are diagrams of the cord circuits, subscribers' line, and line respectively, and the composite page of photographs will give some idea of the Exchange and its accessories.

TELEPHONE NOTES.

The Guernsey Telephone System.

No matter what hostile critics may say, Guernsey ought to be proud of the fact that after meeting all expenses, at the end of five and a half years

their reserve fund equals nearly 20 per cent. of the capital expended. When it is considered that some businesses after more than twenty years' working can only show a reserve fund of little more than half this, it must be conceded that Guernsey stands in a comparatively sound financial position.

We think it a pity that the statistics do not show spare plant and wires, but even this, we are afraid, would not satisfy some critics.

If the Guernsey system, which has been described by the writer in a contemporary as being "hardly used at all," can earn enough to meet all expenses and show a profit of £201 on the year's working, systems owned by others, where the telephone is used, say, "just a little," ought to feel that if they have not struck a diamond mine they have at least struck one of gold.

The Council of gentlemen of good standing in Guernsey who are responsible for the general management of the system no doubt feel honoured at the attention their efforts have attracted in several journals. Eliminating the satisfactory telephone service which they and the inhabitants of the island receive, as a result of their general management, such notice in itself ought to repay them for giving their time and labour gratuitously.

We agree with the writer who states that no fair comparison can be made between the Guernsey telephone conditions—where the system is hardly used at all, but shows a net profit of £201—and those of a British city—where telephones are amply used. The comparison would be unfair to the latter.

Seeing by Telephone.

M. A. Nisco is said to have devised a system for transmitting sight electrically. A metallic net, coated with insulating gum, is formed into a sensitive screen by means of copper wires fixed in the meshes of the net before the insulation hardens. The surface of the screen is afterwards treated and coated with selenium. The numerous copper wires of the metallic net are so arranged that a revolving metallic blade makes contact with every one ten times a second. A battery and telephone-receiver are placed in circuit with the blade and sensitive screen. A picture thrown on the screen causes a variation in current, and this variation affects a telephone and sensitive carbon microphone at the receiving end, so arranged as to produce a spark.

The intensity of the spark corresponds to the intensity of illumination of a particular part of the sensitive screen at the transmitting end of the circuit. A slotted cylinder revolving in synchronism with the contact-blade at the transmitting end allots the spark to its proper position on the receiving-screen. It is stated that only variations in illumination can be produced, and two circuits are required, one for the synchronising apparatus, the other for the transmission of the varying current.

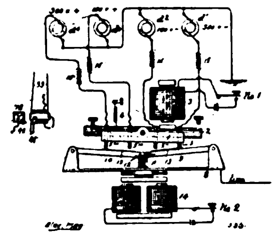
Our next issue will contain some interesting telephone particulars from American Associate Editors. Pressure on our space prevents their inclusion this month.

Telegraphy.

A NEW QUADRUPLEX ARRANGEMENT.

Mr. S. D. Field, of Massachusetts, recognising the unnecessary complications introduced by the resistance in the battery branch and that of the relays, and also by the abrupt changes of sign and power of the batteries in the course of using the two keys, has introduced the following changes:

In Mr. Field's method he combines the two keys into one mechanism, so arranged that all parts work in unison with each other. The arrangement is also such that abrupt reversals are avoided, all current reversals being made by a series of steps instead of the abrupt transition at present employed. The operation of the apparatus shown in Fig. 1 is as follows: Referring to letters A to F in Fig. 2, wherein the position of magnet 3 and spring 4 are reversed with respect to Fig. 1, and magnet 14 is directly beneath frame 8, so that when energised it will pull said frame down, let us assume that magnet 3 in Fig. 1 is energised and key No. 1 is operating, while magnet 14 is idle. Under these conditions a current of 300 negative will pass to line *via* contact 5′ and lever 9, the contact position being



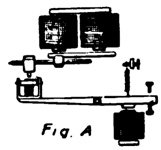


Fig. 1.

as shown at A in Fig. 2. Opening the circuit of magnet 3 will shift the position of bar 1 and send to line the following sequence of currents: First, contact 5″ and lever 9 collide, separating 5′ from lever 9 and diminishing current on line to 100 negative; second, immediately succeeding this contact 10 engages 5″′, separating 9 from 5″ and changing line potential from 100 negative to 100 positive; third, upon the completion of the excursion of the rocking bar contact 5″″ collides with lever 10, separating it from 5″′ and bringing to line a potential of 300 positive, as seen at D in Fig. 2. A reversal has now been accomplished on the line by a series of steps, each of the value of 200 volts, instead of a sharp reversal of 300 negative to 300 positive, as with the practice heretofore.

It is the common practice to incorporate 2 ohms per volt as battery resistance, with the consequence that a disturbance of 300 ohms occurs at the time of passing contacts, caused by the paralleling of the two battery resistances of 600 ohms to each potential of 300 volts. In the Field arrangement but 200 ohms (indicated at 15′) are employed between each contact-point and its attached dynamo. Consequently the simultaneous closing of any two points produces

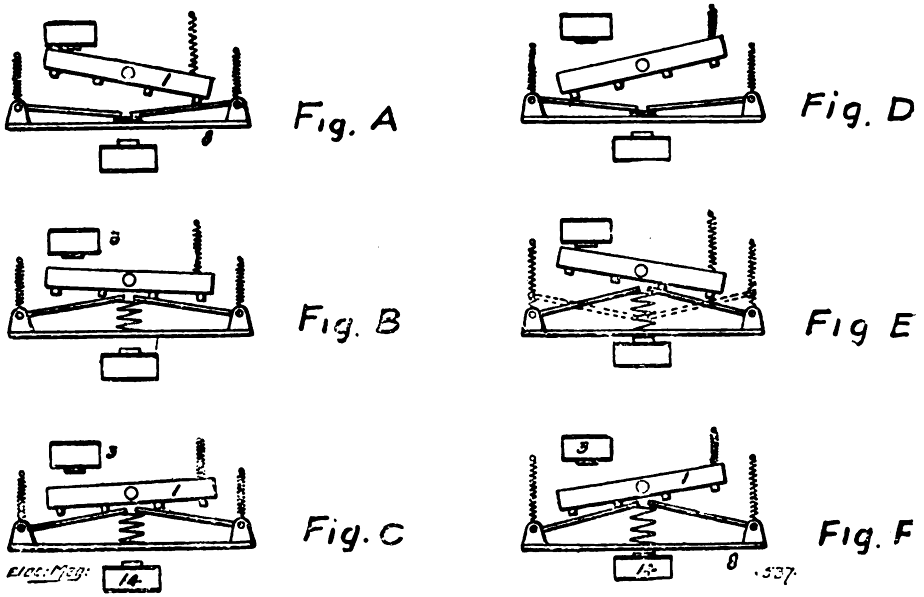


FIG. 2.

a circuit irregularity due to the paralleling of 200 volts or 100 volts only. Besides, this short circuiting is of but half the duration of the present system, as here both contacts are in motion, the one advancing and the other receding from the contact-lever.

The operation of the No. 2 key can best be considered by regarding key No. 1 as idle with circuit closed and key No. 2 as open, in fact, as indicated in Fig. 2, letter A, full negative current being on the line. The closing of No. 2 key lowers frame 8, carrying the two lever contacts, which causes the latter to assume the position shown in full lines E, in Fig. 2, where the line potential has been reduced from 300 volts negative to 100 volts negative, a difference that would be responded to by the No. 2 receiving apparatus to be referred to hereinafter. If key No. 1 remains inactive, the opening of No. 2 would return the contacts to the position shown at A, Fig. 2, giving another change of strength of potential to line—to wit, 300 negative ; but if key No. 1 should become active in the position E, the current will change from 100 negative to 100 positive, as seen at F. If now No. 2 should open, the current change will be from 100 positive to 300 positive, as seen in D. We, therefore, have a single key capable of four different positions without any possibility of conflicting action.

The step-by-step changes of polarity, as well as the changes in strength of current, are effected as regularly as the finger-keys are operated. Again, we have all the safeguards of 2 ohms per volt at all times of the operation, while at all times this resistance is the same for both high and low currents, although the high potential of 300 volts positive or negative when on line has but 200 ohms resistance in its path. The receiving part of the two transmissions is adapted to the peculiarly constructed relay employed in this system.

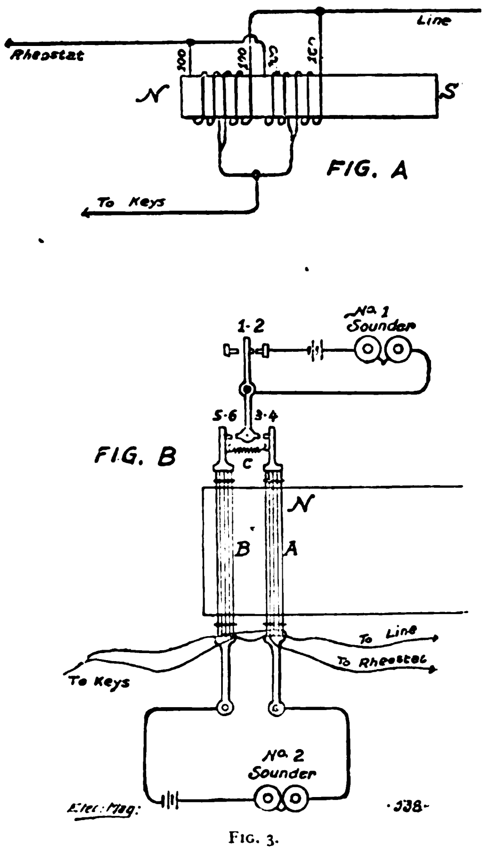


FIG. 3.

In Mr. Field's relay (Fig. 3) advantage is taken of the fact that a wire through which a current is flowing, when in the presence of a magnetic field, is deflected or given a torsional effect, tending to place the wire in a position at right angles to the lines of force. The line coils' relay consists of two parallel helices which surround and cut the lines of force emanating from a locally polarised electro-magnet. It has been found that a local magnetising or polarising current of about 24 watts is more than sufficient to polarise line coils having a resistance of but 50 ohms, so that the deflecting action is more than enough to actuate all necessary relay contact-points for quadruplex working. Where such deflective action is insufficient it is not necessary to increase the line resistance by additional relay windings, nor is it necessary to increase the current—simply increase the local polarisation. The operation of the relay is as follows :

Weak + currents send both coils to the right and open local points 1-2 to operate sounder No. 1. Weak — currents send coils to left and close contact points. Strong + currents send both coils to the right. Coil A then overcomes spring C and opens contact points 3-4 to operate sounder No. 2, No. 1 sounder being held open by pressure of coil B on contact points 5-6. Strong — currents in like manner close No. 1, No. 2 being still open, this time at point 5-6, while contact points 3-4 hold 1-2 closed. Weak currents cannot overcome spring C, but can deflect both coils A and B and thus actuate contact points 1-2.

For balancing and regulating the discharge of the condensers by one movement, a radial rheostat is used, and, as the value of the static charge is to be regarded as a fixed quantity, the adjustment for line leakage is sufficiently accurate to meet all the varying conditions, according to the author of the paper, Mr. Willis H. Jones, who writes in the *Telegraph Age*. No doubt in practice the condensers do not require often to be shifted.

THE AUTOPLEX TELEGRAPH.

This device has been introduced to lighten the labours of the overtaxed telegraphist. It is exhibited in the figure and is the invention of Mr. Horace G. Martin, an electrical engineer and telegrapher, of New York City. The Autoplex is about the size of a Morse relay and is designed to take the place of the present Morse key. The dots and dashes are made by throwing a lever from one contact-point, which automatically

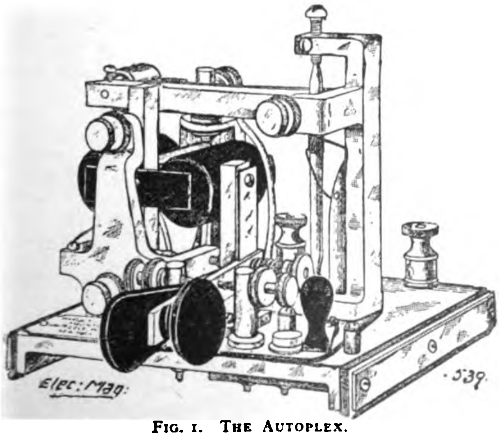


Fig. 1. The Autoplex.

makes dots as long as the contact remains unbroken, to another contact-point which makes dashes, the length of which is governed by the hand controlling the lever. The telegrapher will readily recognise the advantage to him of an instrument which will send with one slight sidewise pressure as many dots as he wishes to transmit, thus saving him the labour of numberless depressions and relaxation of the key, and the consequent strain upon his nervous system. The Autoplex is simply an improvement on the old-fashioned key, in that it makes dots automatically. The button on the Martin Key is similar to that on the old-style instrument, but is operated differently—a horizontal instead of vertical motion being used. When the button is pressed lightly to the right, the machine makes automatic dots in any required number ; the dashes are made by pressing the button to the left. To illustrate : The figure 4 is made in two motions, one to the right for the four dots and one to the left for the dash. The instrument can be adjusted to any desired speed to suit wire conditions, and the sending will " carry " across the continent.

TELEGRAPH NOTES.

The Rowland System.

The Rowland Printing Telegraph system, which has been on trial in Italy for the past year, will, it is reported, be adopted by the Italian Government, the work performed during the experimental period being of a highly satisfactory character to the experts representing the Government.

Telegram Statistics.

To show the enormous growth of the telegraph it may be of interest to note that the total number of telegraph messages transmitted in the United States in 1903 by the telegraph companies was 91,300,000, a number which is exclusive of the many million messages transmitted on the thousands of leased private wires. In the same year Great Britain sent about 93,000,000 messages. In France the record was 50,500,000 messages, in Germany 45,000,000, in Austria-Hungary 30,000,000, in Russia 19,000,000, and in Japan 17,000,000. These figures serve to indicate the tremendous part that the telegraph plays to-day in the world's affairs.

Will Telephones replace Telegraphs ?

Mr. W. J. Phillips writes in the *Telegraph Age*, that he is sometimes asked if the telephone will not eventually replace the telegraph. As facilities are multiplied for doing any particular thing, the more of that particular thing there always is to be done. Despite the marvellous development of the telephone, the volume of telegraph business was never so large as it is to-day. Two telegraph companies, the younger of them extending its system to Honolulu and then pushing it onward to the under side of the world, where there are now important American possessions, and both companies adding, year by year, to their land lines, are offered more messages than they can easily transmit. Every railroad, every turnpike and crossroad that has not already been pre-empted by the telephone companies, is ornamented with a line of poles carrying anywhere from two to ten telegraph wires.

Wireless Telegraphy.

A NEW WAVE-LENGTH STANDARD.

In the March number the interesting experiments of Dr. J. E. Ives, on measurements in oscillatory circuits, were described and an account was promised of the apparatus which was used for the measurement of wave-lengths, which had been specially designed by him and Dr. de Forest. This now appears in the *Electrical World and Engineer*, the instrument being here reproduced in Fig. 1. In the methods hitherto used for such measurements the circuit comprising capacity and inductance, one or both of which are variable, has generally been coupled inductively to the exciting circuit. The present arrangement differs from this in being directly connected to a small portion of the excited circuit, and the voltage drop over this portion is used to excite sympathetic resonance in the circuit of the instrument. The instrument itself consists of two variable inductances and two variable capacities symmetrically placed one on each side of a spark gap, the inductances being each made of two concentric circles of wire on ebonite rings, the outer ones being fixed and the inner ones rigidly connected together and revoluble about a horizontal axis; and the angular position can be read off on a scale. The condensers are made of glass plates of graduated thickness, coated with tinfoil. Fig. 2 shows diagrammatically the connections and the method of using the standard to measure the wave-lengths in an antenna, p, p_1 being points on a contact-bar, between which the drop is taken for excitation (the part between p and p_1 is included in the oscillatory circuit in the case of a closed circuit being used). The inductance and capacity are both then varied, the one by the fine adjustment of tilting the inner coils, and the other by steps as seen in Fig. 1, until the ammeter A in the aerial shows a maximum deflection, when the wave-length of the standard is equal to that of the antenna.

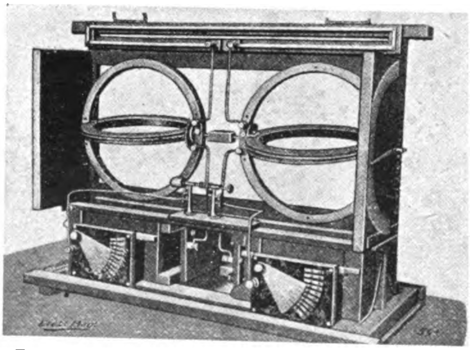


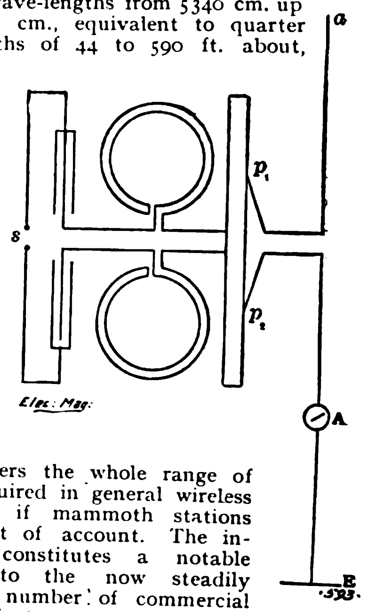
Fig. 1. Dr. Ives' Instrument for Measuring Wave-Lengths.

The advantage of the instrument, as pointed out by Dr. Ives, is that calibration can be easily effected by means of Lecher wires, and in the present case the wires used were of a total length of 500 ft. and were placed 6 in. apart. The wires were divided into lengths of 12 ft. or less, by cutting the wires, making loops at the ends and joining these loops with cord; the loops were bridged over by pieces of wire of the correct length, according to the total length of wire required. The standard was excited by means of a small spark coil, a Geissler tube placed across the parallel wires, and the capacity of the standard varied until the tube glowed, when final adjustment was made by rotating the inductance coils till the glow became a maximum. The standard and the wire were then in resonance, and the quarter wave-length of the standard was equal to the length of the parallel wires.

The results obtained are given in a calibration-curve which shows breaks in continuity owing to the capacity only being adjustable in steps, but the observed and calculated values of the quarter wave-length differ by only a few per cent. In determining the wave-length the most accurate results are obtained by making the Lecher wires three or more quarter wave-lengths long and measuring the distance between the nodes, values 2 to 3 per cent. greater being obtained than with a single quarter wave-length. As in calibrating the standard the single quarter wave-length was used, however, the values given are probably too small by that amount. No trouble from over-tones was observed in the experiments.

From the figures given, the capacity can be varied in twelve steps from 0.0002 microfarad up to 0·025 microfarad, and the inductance from 3500 cm. to 5800 cm., so that the apparatus can measure wave-lengths from 5340 cm. up to 71,800 cm., equivalent to quarter wave-lengths of 44 to 590 ft. about, which covers the whole range of values required in general wireless telegraphy, if mammoth stations be left out of account. The instrument constitutes a notable addition to the now steadily increasing number of commercial technical instruments for wireless telegraphic purposes as opposed to the methods of purely physical interest.

Fig. 2. Diagram of Connections.



ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section at end of Magazine.

Blondlot's N-Rays.

In a recent communication, M. Gutton describes an experiment proving that the action of electro-magnetic waves on a luminescent screen is in every way similar to that of N-rays. The apparatus employed consisted of two cylindrical and parabolic mirrors of zinc, placed exactly opposite each other, two small vertical antennæ being placed in the focal line of one mirror. These were connected by insulated wire to a Blondel oscillator, placed in an adjoining room some ten metres off, so as to eliminate the perturbing effects of sound-waves. The poles of the oscillator were joined to the exterior coatings of two Leyden jars of small capacity, whose interior coatings were connected to the poles of a Holtz machine, in which oscillating sparks were set up. To charge the jars, their exterior coatings were connected together by a glass tube full of water. In the focal line of the second mirror a screen was placed. The experiments were very similar to those of Hertz, the screen taking the place of the resonator. Following up his researches on the origin of the rays evolved during chemical reactions, M. Colson finds that some physical phenomenon such as cooling or compression always occurs simultaneously with such emissions. M. Charpentier discloses some curious facts regarding oscillations in nerves. An electrically excited nerve increases its emission of N-rays. The rays emitted at any point of the nerve may be conducted through a wire on to a screen, and by running the wire up and down the nerve comparisons may be made of the activities at different points. The author finds that the emission is the same at every point. But if two wires are used, and the sum of their actions observed on a screen, then if one wire is fixed and the other made to explore different points, the increase in luminosity will be found to vary from 0 to a maximum. The author suggests that the emission of N-rays is a periodical phenomenon, and that the zero effect observed on the screen is due to interference between two emissions differing in phase by one half-wave length. Some years ago * the author showed that in an electrically excited nerve, oscillations are set up of about 780 or 800 frequency and 36 mm. wave-length. In the above experiment the distance measured between neighbouring points whose emissions were of opposite phase was found to be 16 mm., or half the wave-length found for nervous oscillations. Clearly, then, some correspondence must exist between the two phenomena. In a later communication M. Charpentier describes an experiment which leads him to suppose that nervous oscillations are longitudinal.

M. J. Becquerel finds that inorganic as well as organic bodies have the property, observed by M. Meyer, of losing their emissive power under the action of anæsthetics. The author also advances a general interpretation of all N-ray phenomena. In his opinion, N-rays do not really modify the light emitted by a screen, but the phosphorescent substance absorbs the rays and restores others, which, following the same path as the luminous rays, fall on the retina and increase its sensitivity. A ve.y simple experiment described by the author confirms this theory, which may be extended to N-rays. Compression in a body produces N- and tension N-rays, the existence of which may probably be traced to the molecular movements produced in bodies when in a state of strain or undergoing some molecular transformation. The fact that simple numerical ratios appear to exist between the wave-lengths of different rays would tend to confirm this view, which perhaps would be further strengthened by M. Bichat's discovery that secondary radiations have greater wave-lengths than primary, in conformity with Stokes' law.

* See *C.R.* June 12, 26, July 3, 1899; Feb. 18, March 11, 18, 25, April 29, 1901.

ELECTRO-PHYSICAL NOTES.

Vibration Periods of Simple Electrical Circuits.

In the *Philosophical Magazine* for June Prof. T. A. Pollock considers the question of the periods of the electrical vibrations associated with circuits of simple geometrical form. After a critical review of the results arrived at by previous writers in this field, the author gives in tabular form the results obtained by himself in a refined and lengthy experimental research carried out in the Physical Laboratory of Sydney University. The apparatus employed is described in detail, and an appendix by T. C. Close deals experimentally with the effect of capacity at the ends of a circular resonator.

Structure of Atoms.

In a communication to the Tokio Mathematical and Physical Society, reproduced in the *Philosophical Magazine* for May, Prof. H. Nagaoka gives an interesting investigation of the properties of an atom composed of a ring of negative electrons rotating about a positive electron which, for stability, must be of relatively large mass. Many interesting and obscure features of spectre are shown to be accounted for by such a structure, and also the phenomena of radio-activity, including the formation of the α- and β-rays. An interesting suggestion is made of a possible explanation of the effect of light in reducing electrical resistance, which is most marked in the case of selenium, but occurs to a smaller extent in many other cases, such as metallic filings for example.

The Electric Origin of Rigidity.

In the *Philosophical Magazine* for May, W. Sutherland, in continuation of his former investigations into a Kinetic Theory of Solids, shows that rigidity at absolute zero may be accounted for as a purely electrostatic effect, and that the variation of the rigidity with temperature is susceptible of a purely kinetic explanation. He follows Reinganum in taking the *doublet*, consisting of a positive and a negative electron, as the structural element, both of ether and matter. These doublets he calls neutrons. Account is taken of three distinct ways in which kinetic energy can exist in the ether: firstly, by the rotation of an electron about its centre; secondly, by the rotation of a neutron, which is equivalent to the translation of an electron; and thirdly, by the motion impressed on the doublets of matter by the atoms, this being the origin of radiation.

The Medium and the Ponderomotive Action between Magnets and Currents Induced by Magnets.

Mr. B. Weinberg, in a paper read before the Russian Phys.-Chem. Society, shows the Laplace law to be closely connected with the law of Neumann Faraday on the induction of currents, the latter being thus enunciated: The difference of magnetic potential in two points of the space (being the magneto-motive force) is equal to the rate of cutting of the lines of electric force by a line connecting the two points in question. As, according to the theory of distance effects, the number of lines of magnetic and electric force remains constant on the (infinite) medium being altered, it follows that the ponderomotive action between a magnet and a current cannot depend on the dielectric constant of the medium, as the induction of currents by magnets cannot depend on its magnetic permeability.

Dielectric Constants of some Liquids.

Prof. Borgmann's method, being based on the displacement of the node in the luminous phenomenon shown by exhausted gas tubes, may be applied to a determination of the dielectric constants of insulating liquids, the latter being filled in successively into the same condenser. The condenser used by Miss M. Petrowa * had the shape of a testing-tube, fitted with two plates serving as armature, and a cock. The errors of observation did not exceed 2·5 per cent., the following figures being found:

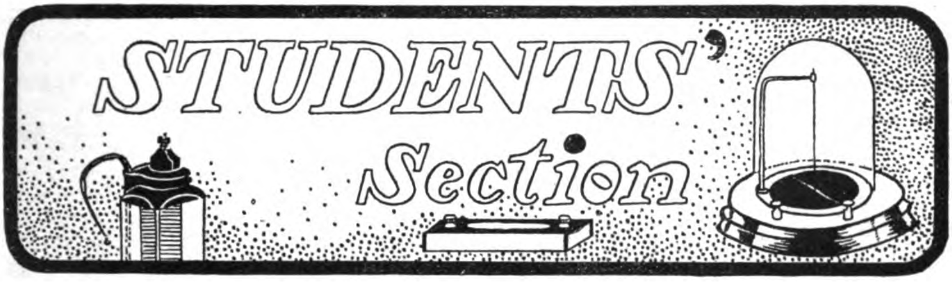
Liquid.	Dielectric Constants.
Xylol	2·11
Benzol	2·3
Sulphuric ether	4·23
Chloroform	4·61
Amyl benzolate	4·84
Liquefied air	1·33

The influence of any variations in temperature proved quite inappreciable, and a piece of radium approached to the tube did not exert any influence on the dielectric constant.

On the Chemical effect of Cathode Rays.

In a paper published in No. 12 of the *Physikalische Zeitschrift*, Dr. E. Bose, investigates the simplest possible case of a chemical effect of cathode rays, to ascertain whether the chemical conversion brought about by the rays is a purely electro-chemical effect according to the Faraday law. In a suitable apparatus, allowing of a large electrolyte surface (about 200 sq. cm.) being radiated upon intensely in the vacuum without internal electrodes, a solution of potash saturated in the hot state was exposed for a long time to the effect of cathode rays, when a reduction would take place and hydrogen be evolved. The amount of electricity absorbed by the electrolyte was measured by means of a hydrogen voltameter. Now, if the effect in question occur according to Faraday's law, the amount of hydrogen derived from the vacuum should be equal to the one evolved in the voltameter. As, however, the former proved ten to thirty and more times the quantity of hydrogen in the voltameter, evidence was shown that there must be in addition to an electro-chemical effect another chemical action produced by the kinetic energy of the cathode ray particles. Similar results are to be anticipated from the chemical effects of Becquerel rays, while this dynamical-chemical effect is likely to prevail much more on account of the higher *fors viva*. On the other hand, when passing to slower and slower cathode rays, as recently obtained, the dynamical-chemical effect should take a more and more secondary *role*, finally leaving a purely electro-chemical effect.

* See paper read before the Russian Physico-Chemical Society.



Students should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles of special interest to them.

Some Illustrations of Approximate Methods of Solving Problems.—II.

By ALFRED HAY, D.Sc., M.I.E.E.

PROBLEM closely allied to the preceding one is the following. Assuming the descending branch BC (Fig. 3) of the magnetisation curve known, to determine the $i-t$ curve when the winding of the ring is suddenly short-circuited.

As soon as the short circuit takes place, the current begins to decrease, and with it the magnetic flux. Now the only E.M.F. maintaining the current is that brought into play by the decreasing flux, so that

$$S \times a \times \text{rate of decrease of } B = ri,$$
$$\text{or rate of decrease of } B = \frac{ri}{Sa} \quad . \; . \; . \; (1)$$

We may, as in dealing with the first problem, assume a number of time-intervals, and suppose that during each of these B decreases by a definite amount. The duration of each interval is provisionally unknown. But from the assumed value of B, at the end of each interval we can find the mean value of B during that interval, and, by reference to the descending branch BC of the magnetisation curve (Fig. 3), the corresponding value of H, and from this again the value of the current i. Having obtained this latter, we substitute in equation 1 above, and so determine the rate of decrease of B during the interval in question. We then finally have

$$\text{duration of interval} = \frac{\text{total change of B}}{\text{rate of change of B}}$$

Thus the durations of the consecutive intervals are determined, and if we find the values of i (from those of B) at the ends of the various intervals, we can plot the $i-t$ curve, showing the gradual decay of the current in the circuit.

CABLE PROBLEM

The next problem which we shall consider arises in connection with the transmission of signals along a submarine cable. Such a cable forms a condenser, one of whose plates or coatings is formed by the conductor of the cable, and the other by the surrounding sea-water. Consider a cable one of whose ends is permanently connected to the positive terminal of a battery, while the other end is earthed, the negative terminal of the battery being also earthed * (see Fig. 4). When everything has become steady, there will be a uniform fall of potential along the cable, as shown in Fig. 5, and a steady current will flow

* In actual signalling work, condensers are interposed between the battery and the sending end of the cable, and between earth and the receiving end.

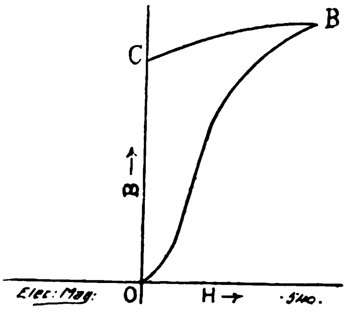


FIG. 3.

Fig. 4.

through it, the current having the same value at every cross-section of the cable, and the stream-lines (see *The Electrical Magazine* for March, page 295) being parallel to the axis of the conductor, and nowhere intersecting its surface. Consider now any short length, say a foot or a yard, of the cable, at any part of its length. This portion of the cable will be at a certain mean potential above the surrounding sea-water, hence it will have a definite electrostatic charge. Each portion of the cable, therefore, while conveying a steady current which is uniformly distributed over its cross-section, also possesses a surface charge, and there will be an *electrostatic* field established across the dielectric, tubes of electric induction (or Faraday tubes) stretching across from the positive charge on the cable to the equal negative charge on the sea-water or sheathing of the cable, as shown in Fig. 6. The amount of charge on a unit-length of cable will vary with its position, and will be directly proportional to its potential. Hence the portion of the cable nearest the battery will be most strongly charged, while the amount of charge in the distant portion of the cable, near its earthed end, will be inappreciable.

Let us now suppose that the circuit has been broken, the cable completely discharged, and then suddenly once more connected to the battery. Before the current can become steady, there must be a uniform distribution of potential along the cable; but this uniform distribution of potential cannot be established until the various portions of the cable have been given the necessary charges to raise them to the required potentials. As a consequence, the *initial* current is far from uniform along the cable, and it *does not flow in parallel stream-lines* such as are ultimately obtained when the steady state has been reached. The current, starting from the battery and entering the cable, will, during the initial stages, largely flow *radially* from the conductor of the cable through its dielectric (as a *displacement* current; see Fig. 4 on page 409 of *The Electrical Magazine* for April). The effect of such a radial flow of current is to produce electrostatic charges on the two surfaces of the dielectric. As the charge increases, the radial flow of current gradually decreases and ultimately stops, the stream-lines becoming more and more nearly parallel to the axis of the conductor. A practically parallel state of flow will be reached very quickly in the portions of the conductor nearest the battery, but a much longer time will elapse before the flow at the far end becomes parallel.

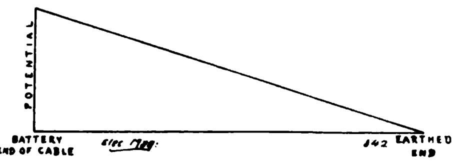


Fig. 5.

A hydraulic analogy is helpful in enabling one to understand the various effects which we have just considered. In the case of a cable whose capacity is entirely negligible, the initial radial flow of current would be negligible also, and the steady state would be reached instantly, the current leaving the cable at its earthed end becoming immediately equal to the current entering the cable at its battery end. With such a cable, no delay whatever would arise in the transmission of signals. The hydraulic analogue of such a cable, entirely destitute of capacity, is a tube with absolutely unyielding walls, filled with an incompressible liquid. Let the ends of such a very long tube be fitted with pistons. If the piston at one end be displaced (corresponding to the connection of the battery), that at the other will immediately begin to move with the same velocity (assuming the liquid to be absolutely incompressible). The hydraulic analogue of an actual cable (*i.e.*, one possessing capacity) is a tube whose walls are more or less *yielding*; if, in the case of such a tube, we start moving the piston at one end, the pressure will cause the tube to expand, and while this radial expansion is taking place, we have a *radial* flow. There will be very little displacement of the piston at the far end until a considerable portion of the tube has been fully distended, just as in the electrical case there will be very little flow of current at the earthed end of the cable until a considerable portion of it has been charged to the potential corresponding to the steady distribution. Having explained, in general terms, the sort of effect which is obtained when a cable having its distant end earthed is suddenly connected to a battery, we next proceed to consider how an approximate numerical solution of the problem may be obtained in any particular case.

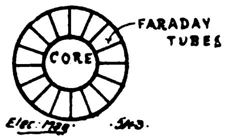


Fig. 6.

We shall take, by way of example, a cable 1000 miles long, having a total conductor-resistance of 1680 ohms, and a total capacity of 360 microfarads. The effect due to the capacity of the cable is the same as that which would be obtained with a cable entirely

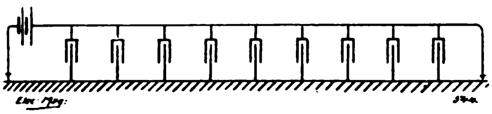


Fig. 7.

destitute of capacity, but having, at numerous equal intervals, condensers connected between it and earth, as shown in Fig. 7. If the number of condensers were made infinite (their total capacity being equal to that of the cable), identically the same result would be obtained as with the actual cable. In the case under consideration, we shall, in the first instance, suppose that the cable is replaced by the arrangement shown in Fig. 8, consisting of three sections, each of resistance $= \frac{1}{3} \times 1680 = 560$ ohms, with two condensers, each of 180 microfarads capacity, connected as shown. Let a steady E.M.F. of 20 volts be impressed on this model of the cable. It is required to investigate the initial stages in the establishment of the current.

When the current has become steady, the P.D. across the first condenser is $\frac{2}{3} \times 20 = 13.33$ volts. Consider the interval from the moment of closing the circuit to the instant when the P.D. across the first condenser reaches .5 volt. The initial P.D. across AB being 20 volts (since B is originally at zero potential), and the P.D. at the end of the interval $20 - .5 = 19.5$ volts, the mean P.D. is 19.75 volts, and the mean current during the interval is $\frac{19.75}{560} = .0353$ ampere. Now, since during this first interval the mean potential of the point B is .25 volt, the mean P.D. across BC cannot exceed this amount, and hence the mean current cannot exceed $\frac{.25}{560} = .000446$ ampere.* This is so small in comparison with the .0353 ampere in the section AB that in an approximate solution we may neglect it, and assume that the whole of the .0353 ampere goes towards charging the first condenser, none of it passing beyond the point B. Now, since by supposition the P.D. across this condenser at the end of the first interval is .5 volt, the corresponding charge is $.5 \times 180 \times 10^{-6} = 90 \times 10^{-6}$ coulombs so that the duration of the interval must be $= \frac{\text{quantity}}{\text{mean current}} = \frac{90 \times 10^{-6}}{.0353} = .00255$ second.

We next consider the second interval, during which we may suppose the P.D. of B to rise from .5 to 1 volt, its mean P.D. being .75 volt, and the mean P.D. across AB being 19.25 volts. This gives for the mean current in AB during the second interval $\frac{19.25}{560} = .0344$ ampere. During the same interval, there will be a current in BC whose mean value is approximately $\frac{.75}{560} = .0013$ ampere. The current charging the first condenser is thus $.0344 - .0013 = .0331$ ampere, and hence the duration of the second interval is $\frac{90 \times 10^{-6}}{.0331} = .00272$ second. The charge which will enter the *second* condenser during this interval is $.0013 \times .00272 = 3.54 \times 10^{-6}$ coulombs, and the P.D. of the point C at the end of the second interval will be approximately $\frac{3.54 \times 10^{-6}}{180 \times 10^{-6}} = .0197$ volt.

Take next the third interval, during which we suppose the P.D. of the point B to rise from 1 to 1.5 volts, giving for the mean value of the current in AB $\frac{18.75}{560} = .0335$ ampere. The mean P.D. across BC during the third interval will be practically 1.25 volts, and the mean current in BC will be $\frac{1.25}{560} = .0022$ ampere. Hence the current charging the first condenser is $.0335 - .0022 = .0313$ ampere, and the duration of the third interval is thus $\frac{90 \times 10^{-6}}{.0313} = .00288$ second. The charge which will enter the second condenser during the third interval is $.0022 \times .00288 = 6.34 \times 10^{-6}$ coulomb, raising the potential of C by $\frac{6.34 \times 10^{-6}}{180 \times 10^{-6}} = .0352$ volt, thereby making the P.D. of the point C at the end of the third interval equal to $.0197 + .0352 = .0549$ volt, and the current in C at the end of this interval to $\frac{.0549}{560} = .000098$ ampere.

Proceeding now to the fourth interval, during which we suppose the potential of B to rise from 1.5 to 2 volts, we have for the mean current in AB, $\frac{18.25}{560} = .0326$ ampere. Now, we found that during the third interval the potential of C increased by .0352 volt; we may, without appreciable error, and merely as a first approximation, assume that it will increase by an equal amount during the fourth interval, so that the mean potential of C during this interval may be taken as .073 volt. We then find: mean

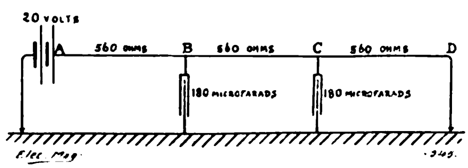


Fig. 8.

* The current will, as a matter of fact, be even less, for as soon as it begins to flow the potential of the point C rises thereby reducing the P.D. across BC.

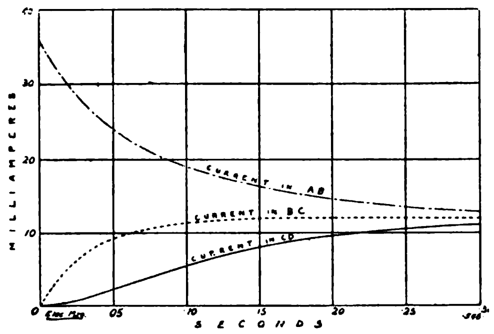


FIG. 9.

current in BC, $\frac{1.67}{560} = .00298$; mean current in CD, $\frac{.073}{560} = .00013$ approximately. Hence: mean current charging condenser at C = .00298 − .00013 = .00285 ampere; mean current charging condenser at B = .0326 − .00298 = .0296 ampere; duration of fourth interval $= \frac{90 \times 10^{-6}}{.0296} = .00304$ second; charge given to condenser at C during fourth interval = .00285 × .00304 = 8.66×10^{-6} coulomb; increase of potential of C during fourth interval $= \frac{8.66 \times 10^{-6}}{180 \times 10^{-6}}$ .0481 (in our first approximation we had assumed it to be .0352); potential of C at end of fourth interval = .0549 + .048 = .103 volt; current in CD at end of interval $= \frac{.103}{560} = .000184$ ampere.

From the data now available for the first four intervals, we can construct a table connecting the values of t with the currents in the three sections AB, BC, and CD. The initial current in AB is clearly $\frac{20}{560} = .0357$ ampere; at the end of the first interval, when $t = .00255$, it is $\frac{19.5}{560} = .0348$; at the end of the second interval, when $t = .00255 + .00272 = .00527$, it is $\frac{19}{560} = .0339$; and so on. Similarly, the initial current in BC is zero to start with; it is $\frac{.5}{560} = .000893$ when $t = .00255$; it is $\frac{.98}{560} = .00175$ when $t = .00527$, &c. The current in CD is initially zero, it is still inappreciable when $t = .00255$, is equal to $\frac{.0197}{560} = .0000352$ when $t = .00527$, &c.

We thus obtain the results shown in the appended tables.

These results are exhibited graphically in Fig. 9, in which the full-line curve shows the current in the last section CD, the dotted curve that in the second section BC, and the chain-dotted curve that in the first section AB (see Fig. 8).

t	Current in AB	Current in BC	Current in CD
0	.0357	0	0
.00255	.0348	.000893	0
.00527	.0339	.00175	.000035
.00815	.0330	.00258	.000098
.01119	.0321	.00339	.000185

By continuing the process, we can complete the table, as given below:

t	Current in AB	Current in BC	Current in CD
.01443	.0312	.00417	.000298
.01788	.0303	.00491	.000452
.02155	.0294	.00563	.000623
.02546	.0286	.00632	.000827
.02966	.0277	.00697	.00106
.03418	.0268	.00759	.00134
.03907	.0259	.00817	.00165
.04439	.0250	.00872	.00199
.05020	.0241	.00922	.00239
.05656	.0232	.00968	.00282
.06359	.0223	.01010	.00330
.07142	.0214	.01048	.00382
.08021	.0205	.01079	.00439
.09012	.0196	.01097	.00500
.10152	.0187	.01130	.00567
.11452	.0179	.01150	.00636
.1300	.0170	.01160	.00711
.1487	.0161	.01180	.00788
.1723	.0152	.01183	.00871
.2035	.0143	.01188	.00955
.2496	.0134	.01190	.01043

Problems in Dynamo Design.—V.

ARMATURE CALCULATIONS.

By ELLIS H. CRAPPER, M.I.E.E.

THE fundamental formula

$$E = \frac{NCn}{10^8 \times 60} \text{ volts . . . (1a)}$$

for the E.M.F. induced in a continuous-current armature may be expressed in various ways, and several writers prefer the following form as a useful expression for practical purposes, *i.e.*,

$$E = 4\phi C\ n \text{ volts . . . (1b)}$$

where ϕ = magnetic flux traversing the armature per pole in megalines (millions of lines of force),

C_s = number of armature conductors connected in series between the brushes,

n_1 = the frequency or number of magnetic cycles per second in hundreds,

$= \frac{\text{revolutions per second} \times \text{number of pairs of poles}}{100}$

If ϕ be given in C.G.S. units and n_1 be the actual periodicity or magnetic cycles per second, then

$$E = 4\phi C_s n_1 \times 10^{-8} \text{ volts} \quad . \; . \; . \quad (1c)$$

As regards the more modern form of the expression for the armature E.M.F. it must be noted that C_s is the total number of turns on the armature divided by the number of paths through the armature from negative to positive brushes, so that for a ring-wound armature the total number of turns = the number of face conductors, and for a drum-wound armature the total number of turns = half the number of face conductors. Then, again, ϕ in the case of a ring-wound armature, is one-half of the magnetic flux per pole (traversing the armature, deduction from the flux traversing the pole-pieces being made for leakage), since the armature flux is divided into two parts, whilst ϕ is the total armature flux in the case of drum-wound armatures. It may also be mentioned that the idea of introducing the frequency n_1 instead of $\frac{n}{60}$ (the revolutions per second) facilitates the calculations relating to the core loss and density, tooth density, eddy current loss and armature inductance, and considerations of sparking at the commutator. The problems connected with the design of armatures are difficult, since the relative magnitudes of the elements in the fundamental formula vary within wide limits and depend upon conditions fixed by heating effects, specific cost and weight, and electro-magnetic reactions. It is proposed to bring the various elements and factors into prominence step by step by introducing a series of graduated exercises.

EXAMPLE 1.—*Determine the areas of cross-section of the armature cores of two machines, one with a ring-wound armature and assuming that* $B = 16{,}000$ *lines per sq. cm., and the other with a drum-wound armature and assuming that* $B = 12{,}000$ *lines per sq. cm., if each armature has* 240 *active conductors and generates* 120 *volts on open circuit at* 1200 *revolutions per minute. By how much must the speed be increased if a terminal P.D. of* 120 *volts is required when a current of* 120 *amperes traverses the armature, assuming the armature resistance in each case to be* 0.025 *ohm, and neglecting armature reactions, resistance of brush contacts, &c.?*

I. By substitution in the formula $E = \frac{NCn}{10^8 \times 60}$ volts, we have, when A = cross-sectional area in sq. cms.,

$$(a) \quad 120 = \frac{(16000 \times A) \times 240 \times 1200}{10^8 \times 60}$$

$$\therefore \quad A = \frac{10000}{64} = 156.25 \text{ sq. cms.}$$

$$(b) \quad 120 = \frac{(12000 \times A) \times 240 \times 1200}{10^8 \times 60}$$

$$\therefore \quad A = \frac{10000}{48} = 208\tfrac{1}{3} \text{ sq. cms.}$$

The total armature magnetic flux in each case is, therefore, 2500000 C.G.S. lines.

II. When a current of 120 amperes passes through the armature the volts lost in the armature are $v = C_a r_a$, consequently if e = the terminal P.D. and E = the E.M.F. generated, we have

$$\left.\begin{aligned} E &= e + v \\ &= e + C_a r_a \end{aligned}\right\} \quad . \; . \; . \quad (2)$$

Consequently the E.M.F. which must be generated to satisfy the conditions given is

$$\begin{aligned} E &= 120 + (120 \times 0.025) \\ &= 123 \text{ volts} \end{aligned}$$

and from (1a) we have

$$123 = \frac{2500000 \times 240 \times n}{10^8 \times 60}$$

and $n = 1230$ r.p.m.

therefore, the speed must be increased half a revolution per second. It may be mentioned here that the order of magnitudes of the volts lost in the armature and of the volts lost due to resistance of brush contacts are about $2\frac{1}{2}$ to 3 per cent. and 1 per cent. respectively of the terminal voltage. As an example of using formula 1b the following exercise is given.

EXAMPLE 2.—*A* 550-*kw traction generator gives a terminal pressure of* 550 *volts at a speed of* 120 *revolutions per minute. There are* 10 *poles, and each of the* 10 *armature circuits has a resistance of* 0.145 *ohm. The armature is ring-wound and has* 1000 *turns of wire on it. Determine the magnetic flux per pole through the armature, if the drop in volts due to brush contact resistance is* 1 *per cent. of the terminal voltage.*

The total current $= \frac{550000}{550} = 1000$ amperes,

$\therefore$ each armature carries $\frac{1000}{10}$ or 100 amperes,

$\therefore$ volts lost in armature $= C_a r_a$

$= 100 \times 0.145 = 14.5$ volts

and drop due to brush contact resistance

$\frac{1}{100} \times 550 = 5.5$ volts

$\therefore$ E.M.F. generated $= 550 + 14.5 + 5.5$

$= 570$ volts

Let ϕ_1 denote armature flux per pole, then ϕ (in formula 1b) $= \frac{1}{2}\phi_1$, since the armature is ring wound. $C_s = \frac{1000}{10} = 100$ conductors in series per armature circuit, and the periodicity $n_1 = \frac{120}{60} \times 5 \times \frac{1}{100} = \frac{1}{10}$. By substitution, we have

$$E = 4\phi C_s n_1$$

$$570 = 4 \times \frac{\phi_1}{2} \times 100 \times \tfrac{1}{10}$$

and $\phi_1 = \frac{57}{2} = 28.5$ megalines.

There is considerable difference of opinion as to the best method of fixing the dimensions of the armature, and several working formula have been proposed for the determination of the diameter and length of the armature. For the present only smooth-cored armatures will be considered. These formulæ have been deduced on the assumption that some definite relation exists between the normal energy output of the armature core and its dimensions, and by introducing *output-coefficients*, working formulæ result which, used in conjunction with curves plotted from data of similar machines, serve the purpose of enabling the designer to obtain very satisfactory results. The relation existing between the size and output may be obtained by assuming (1) that the armature output is related to the *volume* of the armature core, or (2) that the output is related to the *surface* of the armature core.

Dr. S. P. Thompson has shown that the rational formula

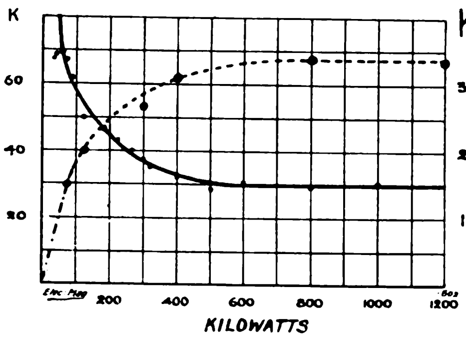


FIG. 1.

$$d^2l = \frac{60.8 \times 10^{10}}{B_g \times q_1 \times \psi} \times \frac{kw}{n} \quad . \; . \; . \; (2a)$$

may be deduced from first principles, so that we may write

$$d^2l = \kappa \times \frac{kw}{n} \quad . \; . \; . \; (2b)$$

which is known as Esson's formula. In (2a)

B_g = mean flux-density at the pole face ;
l = gross length of the armature core, or length of the pole-face from front to back ;
d = diameter of the armature core ;
q_1 = number of ampere-conductors per unit-length of periphery, or *specific-load ;*
ψ = ratio of the equivalent pole-span to the pole-pitch ;
n = revolutions per minute ;
kw = output of armature in kilowatts.

In connection with these formula Dr Thompson points out that if B_g be taken at 45,000 lines per square inch, q_1 as 600 per inch of periphery, and ψ as 0.70, κ = 32000. κ is termed the *output-coefficient* by Esson, and its value is given by $\frac{d^2l \times n}{kw}$. A little consideration shows that its value varies widely for different types and sizes of machines ; that this must be so is obvious when it is remembered that the values of the flux-densities and ampere-densities are different in small and large machines.

From equation (2b) we may write

$$\text{output in kilowatts} = d^2l \times n \times \frac{1}{\kappa}$$
$$= k\, d^2l \times n \quad . \; . \; . \; (2c)$$

which is sometimes called the *output equation.* A similar equation, *i.e.*, $kw = k_1\, d^2l\, n \times 10^{-6}$, has been used by Kapp. Now, for a well-designed series of machines with similar constants the value of the output-coefficient varies in a perfectly regular manner according to the size of the machine, and the full-line curve in Fig. 1—due to Mr. A. C. Eborall, M.I.E.E.—for a standard series of modern direct-current dynamos, all built to a certain standard specification, will be useful for ascertaining the values of the output-coefficient, κ, for machines of different outputs. Some engineers plot values of κ against the *specific-output*, which may be defined as the output in watts divided by the speed in revolutions per minute ; the specific-output is obviously a constant for a given machine, and a curve obtained in terms of κ and specific-output and corresponding to the values given by Mr. Eborall is shown by the dotted curve in Fig. 1.

EXAMPLE 3.—*It is required to determine the diameter and length of the core of a direct-current armature, the capacity of which is 125 kw's, and runs at 400 revolutions per minute, assuming that* $\frac{d}{l} = 3$. *Also determine the peripheral velocity of the armature.*

Applying Esson's formula, the output-coefficient as given by the full-line curve of Fig. 1 for an output of 125 kw is 50, and by substitution we have

$$d^2l = \kappa \frac{kw \times 10^3}{n}$$
$$= 50 \times \frac{125 \times 10^3}{400}$$
$$= \frac{125000}{8}$$
$$\text{but } \frac{d}{l} = 3 \; \therefore \; d^2l = \frac{d^3}{3}$$
$$\text{and } d^3 = \frac{3 \times 125000}{8}$$
$$\therefore d = \frac{72}{2} = 36 \text{ inches}$$
$$\text{and } l = \frac{d}{3} = 12 \text{ inches}$$

The circumference of the armature is $\frac{\pi d}{12}$ feet, and the peripheral veloctity, v_a, is

$$v_a = \frac{\pi d}{12} \times 400$$
$$= 3770 \text{ feet per minute.}$$

(*To be continued.*)

From Professor to Student.

MY aim is to be an electrical engineer—if I must specialise, a central station man. I am serving an apprenticeship for a fitter in a locomotive works. I should like you to answer the following :

(1) *Would it be best to serve my full time, five years, or shorten it to three or four ?*

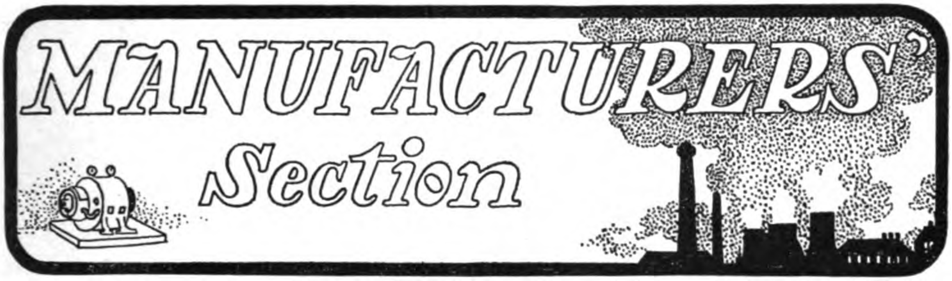
(2) *What course of study should I take ? (I am rather deaf, so cannot attend classes, and cannot afford much expense, so I must study at home.)*

(3) *Are the City and Guilds Certificates of much use if I gain them ? If so, what books would be best to cover the "Electric Light and Power" ordinary grade syllabus if one had a very elementary knowledge ?*

As regards (1), we should advise our correspondent to serve his full time. Should his hope of becoming an electrical engineer be disappointed he will then, at any rate, have received a very thorough training as a fitter, and will have something to fall back upon.

(2) The physical infirmity mentioned by our correspondent certainly places him at a considerable disadvantage. We should suggest to him to try one of the correspondence colleges, which he will find advertised in the weekly electrical papers (*e.g.*, in *The Electrician*). Many who have had no opportunity of attending classes have derived very great benefit from such correspondence courses.

(3) The certificates are certainly worth having. As regards books, we can recommend the following : Tyson Sewell's *Elements of Electrical Engineering* (Crosby Lockwood & Sons) ; Ayrton's *Practical Electricity* (Cassell & Co.) ; Perren Maycock's *Electric Lighting and Power Distribution*, vols. i. and ii. (Whittaker & Co.).



A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section at end of Magazine.

The Bradford Works of the Phoenix Dynamo Manufacturing Co. Ltd.

OUR regular readers will have noticed in previous issues our composite pages of photos presenting records of the work of English and foreign manufactures in the field of electrical enterprise. It will be our pleasing duty to insert these from time to time, and following up our brief description of Graham, Morton & Co.'s Works last month, and referring as we do on another page to the City of Bradford Exhibition, we take this opportunity of presenting our readers with some particulars of the largest firm of electrical manufacturers in the Bradford district. The Phœnix Dynamo Manufacturing Co. quite recently took over the business of Messrs. Roslyn & Fynn, whose works at Thornbury they have entirely remodelled and brought up to date. Electric driving on the group system is employed throughout the works, current being supplied from the Bradford Corporation mains. The design of all classes of electrical apparatus manufactured by the firm has been carefully considered, and standardisation effected on modern lines, so that the company can present its customers with electrical machinery of the highest class, and conforming with the very latest practice. Dynamos and motors, both alternating and direct current, are the chief specialities, and these are manufactured in standard sizes up to 1000 h.p. The direct-current designs of the company have been before the electrical world for many years, and it is interesting to note that they were the first makers in the North of England of enclosed and semi-enclosed motors. The attached illustration represents two 200-h.p. direct-current motors, which have just been completed to the order of Messrs. Thwaites Bros. for the Japanese Government. A glance over the chief "points" of these will at once given the idea of a machine designed with close regard to efficiency, combined with a reasonable economy in material. The motors in question are the eight-pole open type, running at 300 r.p.m., the illustration depicting them connected for the Hopkinson test at the works. It was the practice of early electrical manufacturers to make dynamo electric machinery of a very substantial character, but subsequent experience proved that extreme solidity was ofttimes obtained at the expense of efficiency. This point has received due consideration by the Phœnix Dynamo Co., in all its designs.

The Bradford Corporation has electrical machinery of the Phœnix Dynamo Co.'s manufacture on its mains aggregating over 2300 h.p., and this substantial figure has been arrived at in keen competiton during the past five years. Within a radius of twenty miles of Bradford, we may note that the company has some 5000 h.p. of its apparatus in operation.

Polyphase machinery, that is, two- and three-phase motors, have been made a speciality for some time past. American and Continental designs have been carefully studied by a highly skilled technical staff, and the latest thought upon this sphere of electrical engineering is embodied in the alternators and motors produced. We refer specially to these machines in our description of the company's stand at the Bradford Exhibition. The development of electrical supply companies in bulk has given a great impetus to the manufacture of polyphase machinery, and when the stern competition in this direction is considered, the fact that

the designs of the company have met with such a reception speaks highly for their excellence.

The works cover an area of some three acres, and comprise the following group of buildings :

(1) Machine shops.
(2) Pattern shop and stores.
(3) Office buildings, &c.

The machine shops consist of a building in three bays, each 150 ft. long, two of 40 ft. span, each served by a ten-ton three-motor crane. The third bay is 30 ft. span, the lower portion being used for armature-winding department and tool-room, with a brass and switch gallery above.

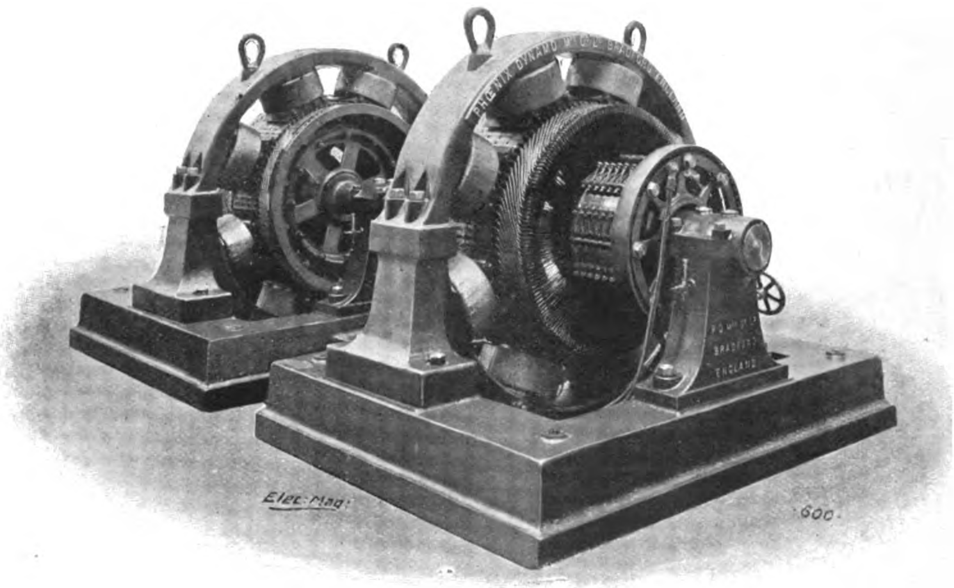
The test-bed is arranged at the end of one of the 40-ft. bays, and is controlled by a switchboard designed for six sets of machines running on Hopkinson test at the same time. The circuits are so arranged that direct current of 100, 230, and 460 volts can be supplied, and single, two- and three-phase current, at any voltage up to 3000 volts, 50 cycles. Regarding the testing, we would say that every machine, after assembling, is run for a six-hour test at full load (or longer, if specified), readings being taken at certain periods throughout the test, and checked by standard instruments at the conclusion of test.

At the end of the run, after the temperatures are taken, an insulation test of 2000 volts alternating is applied between the frame and windings of the machines for a period of five minutes.

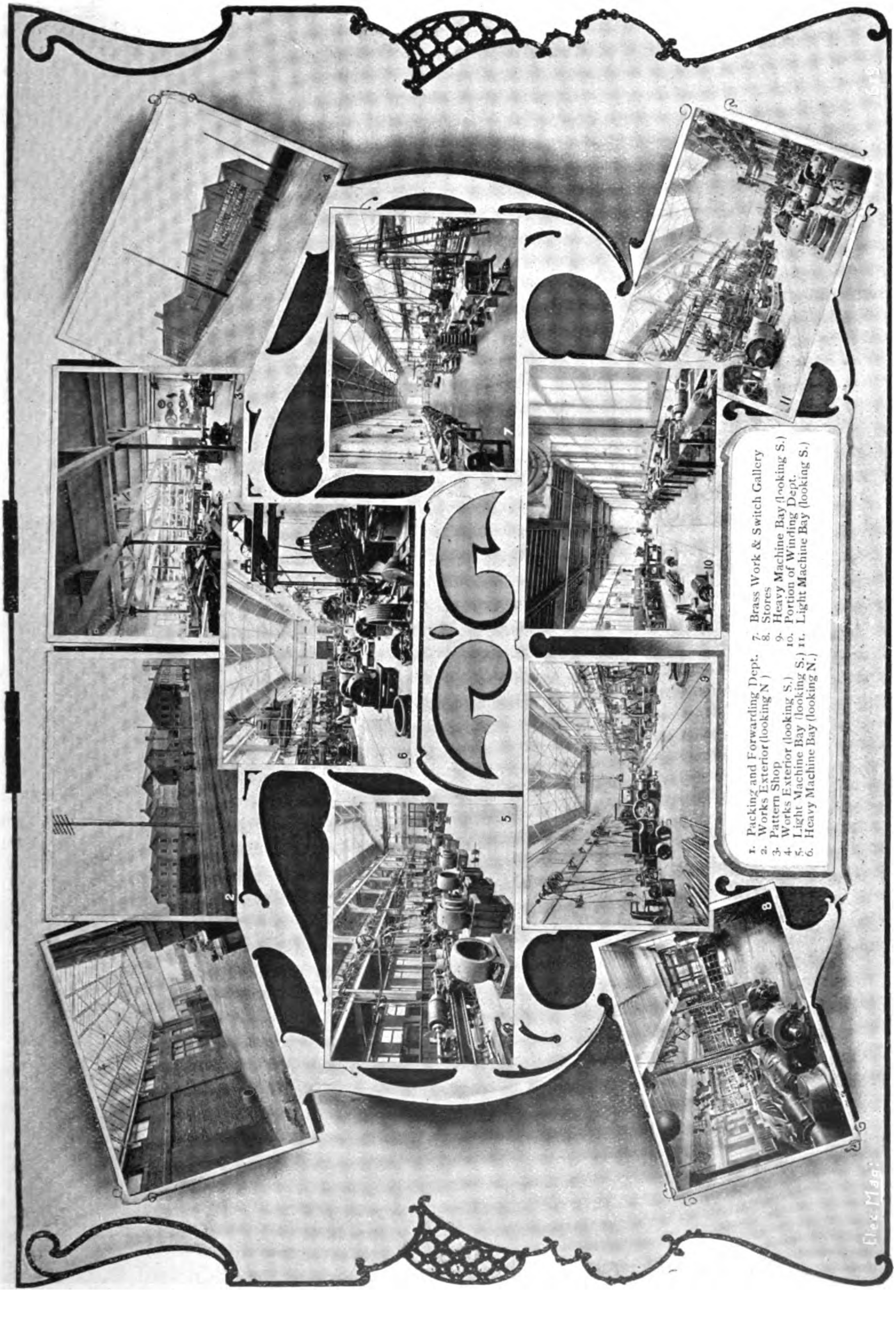
The two machine bays are arranged, one for lighter machines up to 50 kw., and the other for machines up to 1000 h.p. We notice in particular during our visit the modern character of the tools employed, and would mention, such as the Jones & Lamson turrett lathes, Gisholt lathes, &c., and especially that all the shafts are ground after turning by a large Brown & Sharpe grinding-machine.

The tool-room is an important centre of the works, occupied in the production of jigs, templates, &c., while all reference gauges are kept there. The tool-room has charge of all lathe and planer tools used throughout the shops, and no man is permitted to grind his own tools. When a new tool is required he has simply to ring a bell and call a boy from the tool-room when a new tool of the required shape is brought to him. By means of a Gisholt tool-grinder, grinding to standard angles and shapes, reproduction of the best form of tool is always possible at a very low labour cost, and we were pleased to note that full use is made of the new high-speed steels, there being in particular two lathes built specially to stand high speeds and feeds for shaft work.

In the brass-finishing shop, full use is made of multi-spindle drills, milling-machines with gang cutters and press tools for rapid and economical production of work. A



Two 200-h.p. "P.D.M." Motors, coupled for Hopkinson Test.



Bradford Works of the Phoenix Dynamo Manufacturing Co. Ltd.

compact brass foundry is in full swing at the works, and is capable of turning out a couple of tons per week. There is also a well-equipped smith's shop, fitted with power-hammer, pressure-blowers, this and the foundry being a special building leading off the heavy machine bay.

The space between the machine shops and the stores is roofed in, and makes a well-arranged forwarding department for packing. The stores are on the ground floor of a separate building, and have a floor area of over 4000 ft., and is well arranged with bins, racks, &c., for the storage of all raw material used in the company's manufactures.

Above the stores is the pattern shop, having a similar area and fitted with various machine tools, driven by separate motors, required for pattern-making.

In the machine shop itself the group system of driving is employed, except in the case of special heavy tools, which are not always at work, when separate motors are employed.

The office, at the front of the works building, consists on the ground floor of the general offices, estimating department, private offices, waiting-room, &c., and beyond these a commodious mess-room for the men has been thoughtfully provided. On the upper floor are situated the drawing-office, designers' offices, private offices, staff dining-room, blue-print room, and photographic dark-room. Above the men's mess-room is a winding-room, in which girls are employed for coil-forming, taping, and similar operations—this room being provided with three automatic coil-winding machines and several taping-machines.

The number of machine tools in the works is 103, and the total number of motors fitted is twenty-eight, the majority being 230 volts and some 460. The machine tools vary in weight from twenty tons down to the smaller classes of lathes, &c.

In conclusion, we would state that the Phœnix Dynamo Manufacturing Co. started as a private concern in June 1892. It then occupied small premises in Thornton Road, Bradford, from which they removed two or three years later to what were larger premises in Hubert Street. The business, however, progressing, rendered a further removal necessary in July 1899, to Joseph Street Works. The next three years, however, saw the concern outgrow these premises, and it was at the end of 1902 decided to build and equip new works in one of the outlying portions of the city. At this period, however, the opportunity arose to acquire the business and new works of Messrs. Rosling & Fynn, who at that time were in liquidation, and, early in February 1903, the business and new works of that firm were purchased by the company. In June of that year the concern was turned into a limited liability company. As an example of a modernised electrical manufactory, the company's works have no equal in the district, and we are pleased to present the above details as some answer to those critics of British methods who see little else but decay in this industry, for whose birth, growth, and present existence English scientists are so largely responsible.

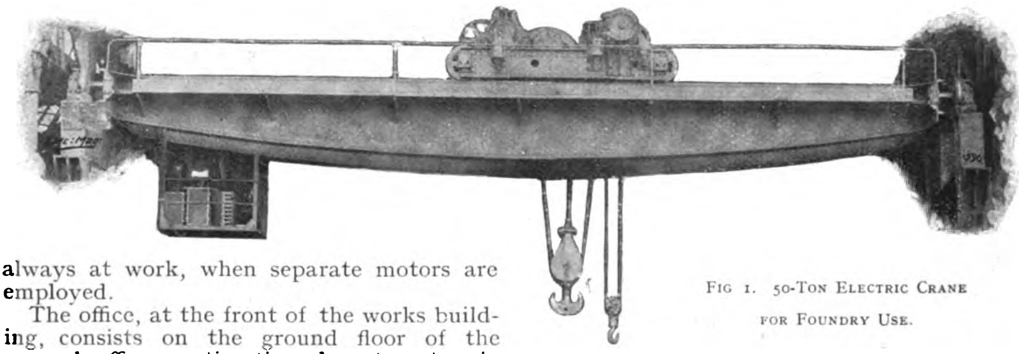


FIG 1. 50-TON ELECTRIC CRANE FOR FOUNDRY USE.

ELECTRIC CRANES.

ANY prejudice which may have originally existed as to the utility of the electric crane must by this time have been fully proved unfounded, judging by the excellent examples now on the market. In this respect British manufacturers have maintained a brisk trade, despite the efforts of foreign competitors, whose designs have in the majority of cases been very greatly boomed. We do not infer that these designs are in any way inferior to our own, but we have grown so familiar with the outcry against British engineers and their methods, and so long waited its confirmation, that we feel assured there has been in the manufacture of electric cranes a distinct blank which our own engineers have successfully filled. Messrs. Thomas Broadbent and Sons, Ltd., Central Iron Works, Huddersfield, have done some valuable work in the production of electric cranes, and if the number they have in use, and the manner in which their works are being extended, is any criterion, they have reason to congratulate themselves on their designs. These have been standardised under the head of Multi-motor and Mono-motor cranes. Fig. 1 illustrates an example of the former supplied to Messrs. John Spencer and Sons, Newcastle, for use in their new plate-rolling mills. The crane has a span

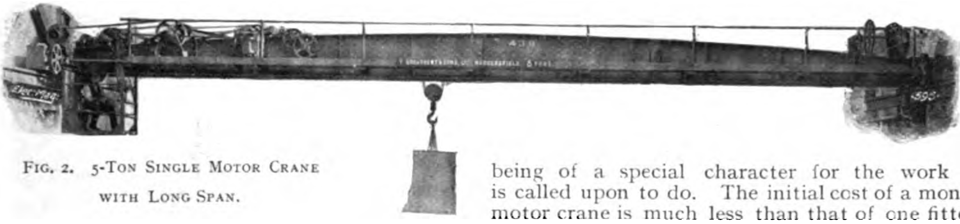


FIG. 2. 5-TON SINGLE MOTOR CRANE WITH LONG SPAN.

between the central rails of 50 ft. 3 in., and can be worked at the following speeds :

Main hoist . .	15 tons at	6 ft. per min.
Auxiliary hoist .	5 ,, ,,	60 ft. per min.
Longitudinal travel		120 ft. per min.
Cross travel . .		50 ft. per min.

This crane has four motors for the distinct operations of hoisting the main and light load respectively, and travelling longitudinally and transversely, the motors being controlled from a cage hung below the crane girders. The hoisting-motor is fitted with an automatic mechanical brake, the pressure of which is applied by the load, the friction being therefore directly proportional to the load. In hoisting, there is a total absence of brake friction, as the brake pulley is arranged on the free wheel principle. In addition, there is an electric brake fitted to the armature of the hoisting motor. The brake is operated by a solenoid, and, should the supply of current fail from any cause, is immediately applied. This will at once prevent the running down of the load. Multi-motor cranes, if used for long spans, must of necessity be heavier than mono-motor cranes, as the travelling-crab can only be placed above the span of the girders. This position necessitates a stronger girder for a given span than would be required with the mono-motor crane.

In Fig. 2 a type of the latter is depicted, and it will be noticed that the span between the rails is a very long one—62 ft. 11 in. This crane has a maximum lift of five tons, and a hoisting speed of 15 ft. per minute, a longitudinal travel of 150 ft. per minute, and a cross travel of 50 ft. per minute. One motor only is employed, the various motions being obtained by means of cross and open belts. The motor is compound wound, and runs in one direction only, its rating and construction being of a special character for the work it is called upon to do. The initial cost of a mono-motor crane is much less than that of one fitted with three or more motors, but the makers claim that under certain circumstances it is in every way as efficient. They have paid careful attention to the design of this type, and recommend it as in every way satisfactory, being free from electrical complications and easily controlled from a travelling-cradle or the floor. In some cases improved self-locking friction clutches are used in place of cross and open belts.

Fig. 3 is a five-ton three-motor overhead travelling crane as built for the Carnforth Hematite Iron Company. As will be seen, this is used for open-air service. It has a span of 75 ft. between rail centres. It will serve to depict the variety of construction which Messrs. Broadbent are prepared to undertake. We must refer our readers to the superb catalogue recently issued by this firm, in which will be found many excellent illustrations of the cranes they manufacture. We need hardly remind our readers that a large quantity of these cranes are in use in many central stations.

THE DICK-KERR HIGH-TENSION OIL SWITCH.

THE rapidly increasing and extensive application to present-day commercial requirements of high-tension currents for the transmission of power has brought prominently forward the necessity of providing suitable and reliable apparatus for handling with safety currents of high potential. The high-tension oil switches which Dick Kerr & Co. Ltd., have placed on the market possess some novel features, and as they are being largely used on systems at home and abroad a short account of their construction and method of working will be interesting to our readers.

The switches are supplied singly or in multiples

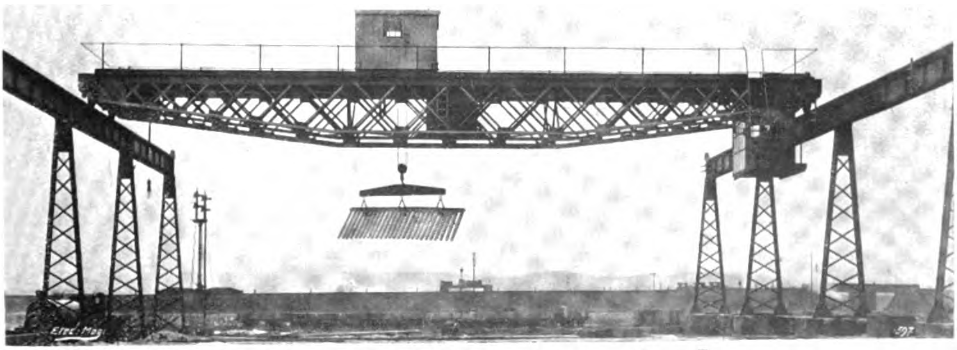
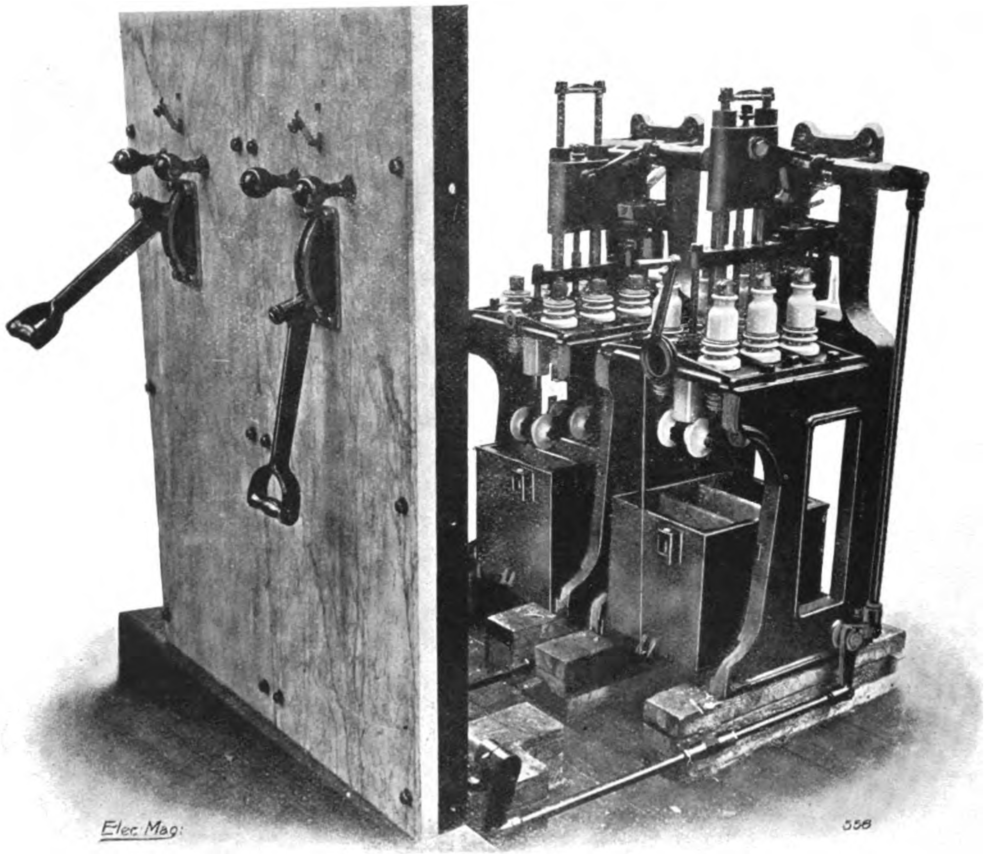


FIG. 3. OUTDOOR OVERHEAD TRAVELLING CRANE, TO LIFT 5 TONS

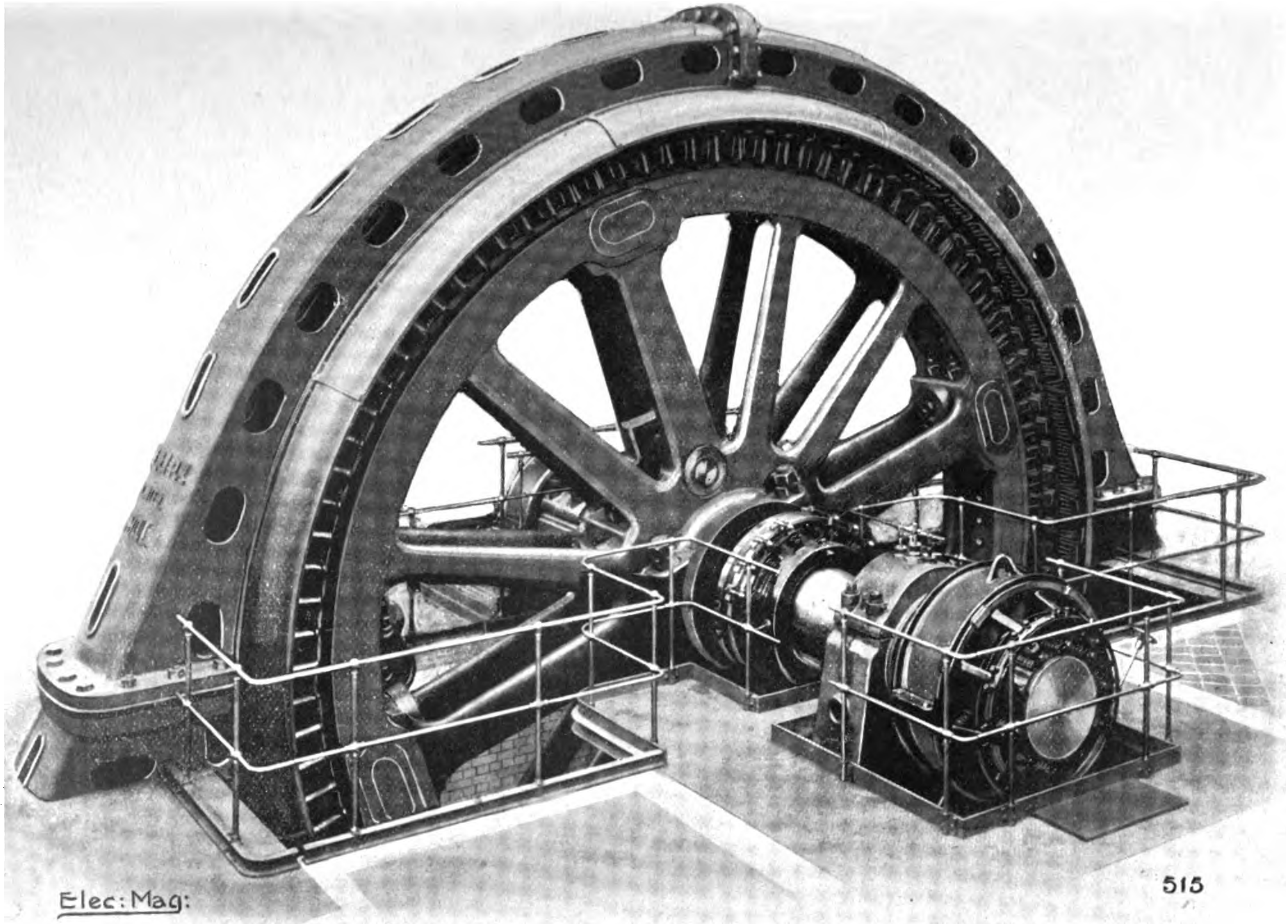


DICK-KERR HIGH TENSION OIL SWITCH, WITH OPERATING GEAR.

to suit any number of phases, and may be operated automatically. The main terminals for connecting the cables are secured to vertical rods highly insulated with mica-sleeves and porcelain insulators with large creeping surface; they are held in position by substantial insulators securely fixed to a cast-iron webbed plate, bolted to the cast-iron frame. This plate acts as a cover to the oil-box which surrounds the switches. From the lower ends of the vertical rods depend the copper jaws engaging the switch-blade. The switch-blade is carried horizontally in a heavy porcelain insulator and attached to a turned steel rod, secured at the upper end to a crosshead, guide-rods, and weight. The switches are enclosed in a large oil-box, which may be lowered by means of a winch attached to the frame. The oil-box is lined with impregnated material and fitted with fireproof partitions consisting of marble or other suitable material for separating the various switches, and when the box is fixed in position it entirely encloses the live contacts of the switch. It is also dustproof and oil-tight. An oil-gauge is fitted to the side of the box, by which the height of oil in the box may readily be observed. The top of the cast-iron frame is provided with columns for supporting the trip-gear, weight, and horizontal crosshead from which depend the vertical rods attached to the switch-blades.

The trip-gear is attached to a series of links connected through cranks to the operating-handle on the switchboard. To close the switch the handle must be forced down until the spring-bolt locks. This motion raises the weight and crosshead, and closes the trip-gear and switch. The switch may be opened by withdrawing the spring-bolt and raising the switch-handle. On releasing the handle the trip-gear is immediately brought into action, the weight falls smartly on the crosshead and throws the switch-blades out with a quick action.

In addition to the ordinary operating-handle, each switch is provided with an emergency throw-out. This takes the form of a solenoid attached to the frame of the switch, the armature of which actuates the trip gear. The local circuit for operating the solenoid is closed by a small press-button switch placed immediately above the main switch-handle. For larger work a special type similar in design to the foregoing is manufactured and operated by a motor. This does away with the link and crank gear connecting the switch to the switchboard.



Standard Types of Electrical Apparatus. I.

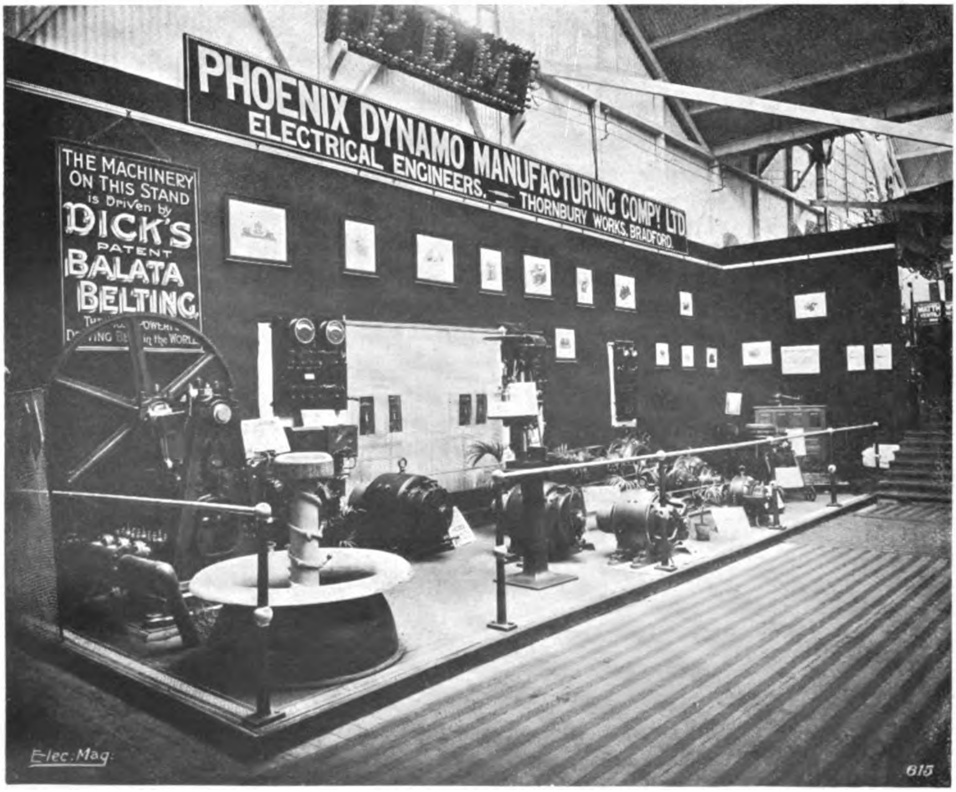
One of two 3000–3500 kilowatt, two-phase alternators supplied by Witting, Eborall & Co., Ltd., to the Metropolitan Electric Supply Co., Willesden Power Station. Each alternator is direct-coupled to a 5000 h.p. Sulzer engine (by the same contractors), and operates at 10,500 volts per phase, 60 cycles, and 75 revolutions per minnte. These plants are the largest engine-driven units at present operating in Europe.

THE CITY OF BRADFORD EXHIBITION.

THE City of Bradford is to be congratulated on its textile exhibition and for its enterprise in celebrating on so large a scale an epoch-making event in the history of textile manufactures—the invention of the loom. A permanent record of both the exhibition and it cause will remain in the magnificent Cartwright Memorial Hall, but we venture to predict what will be to us a more important memento of the exhibition, the establishment of the claims of electricity as *the* power adjunct to all textile machines. That there are strong indications of activity in this quarter is evidenced by the presence of more than one electrical firm of repute in the district, and by the number of exhibitors of electrical apparatus which, though not large was in every way representative of standard modern practice in the art. Textile manufacturers are, however, slow to learn what electricity can do for them, and few have wholly embraced its advantages, the majority remaining onlookers or experimenters on a small scale. Still, there has been progress, and in presenting our readers with a short account of the electricity exhibits in this the centre of an important branch of textile trade, we do not intend to take the manufacturers to task for what may appear to us a backward policy on their part. We are convinced that they now realise the economics and benefits of electric driving, and in good time will take advantage of them. Those interested in work of this character on the Continent are referred to page 33, Power Section, where an illustrated account of the complete electrical operation of a mill is given, together with figures comparing electricity with steam.

Phœnix Dynamo Manufacturing Co. Ltd.

This company has the largest electrical exhibit in the Industrial Hall, a circumstance quite in keeping with its local status

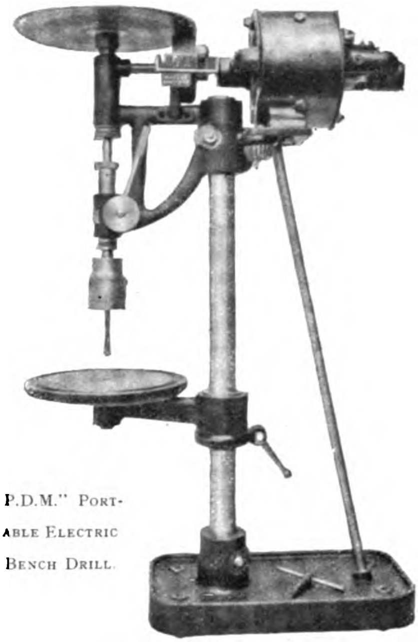


PHŒNIX DYNAMO MANUFACTURING COMPANY'S STAND, BRADFORD EXHIBITION.

as the biggest manufacturing electrical firm in Bradford. We refer to the works of the company, giving some illustrations of these and their chief products, on another page. The accompanying view of the stand will explain its comprehensive character, comprising three standard semi-enclosed d.c. motors of 20–10 and 6 b.h.p. respectively; 1–10 b.h.p. motor of similar design, driving a 3-throw ram pump for boiler feeding; one P.D.M. standard 15 k w 3-phase generator 200 volts, 50 cycles 1000 revolutions, 2-3 phase motors of 12 and 3½ b.h.p. respectively; one portable electric deck-drilling-machine, and one "Phœnix electric bench or pillar-drilling machine." We illustrate the latter in the adjoining cut. The drill is shown in operation, and is a very handy little machine, and some idea of its capabilities may be gathered from the following:

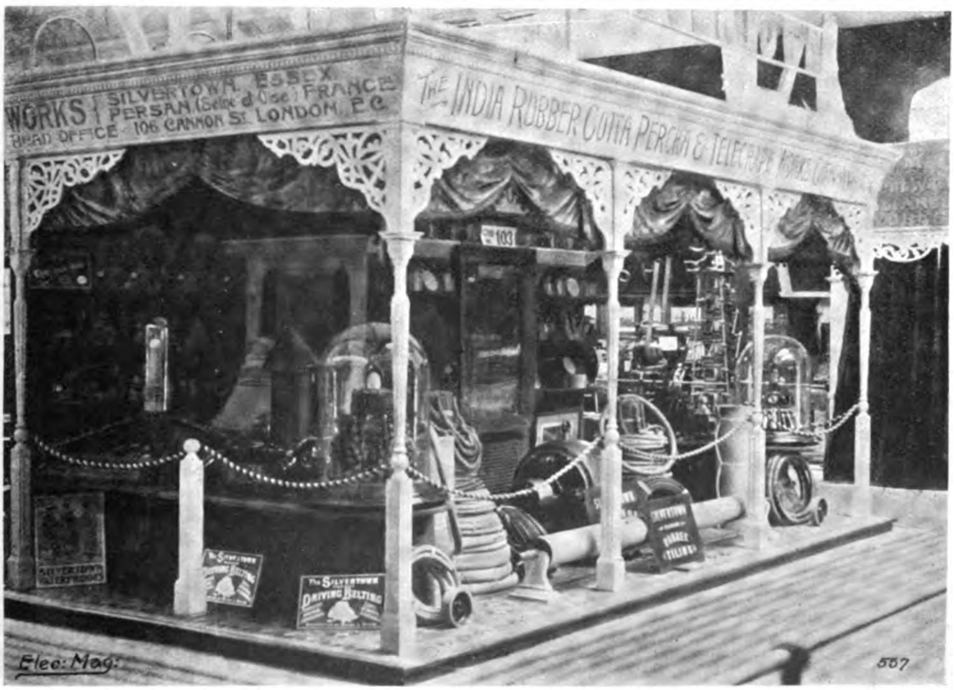
Hard drawn brass	¼" drill,	⅞" per min.
Cast iron . .	¼"	,,	2½"	,,
Brass . . .	½"	,,	3"	,,
Boiler plate . .	½"	,,	1½"	,,

The tool is fitted on the head stock, a standard ¼-½ horse-power P.D.M. motor, with stoked armature self-oiling bearing and carbon brushes. A friction pulley on the motor shaft presses against the vertical drill spindle, and can be radically adjusted for various speeds by a lever and pointer indicating the correct speed for a given size of drill.



"P.D.M." PORTABLE ELECTRIC BENCH DRILL.

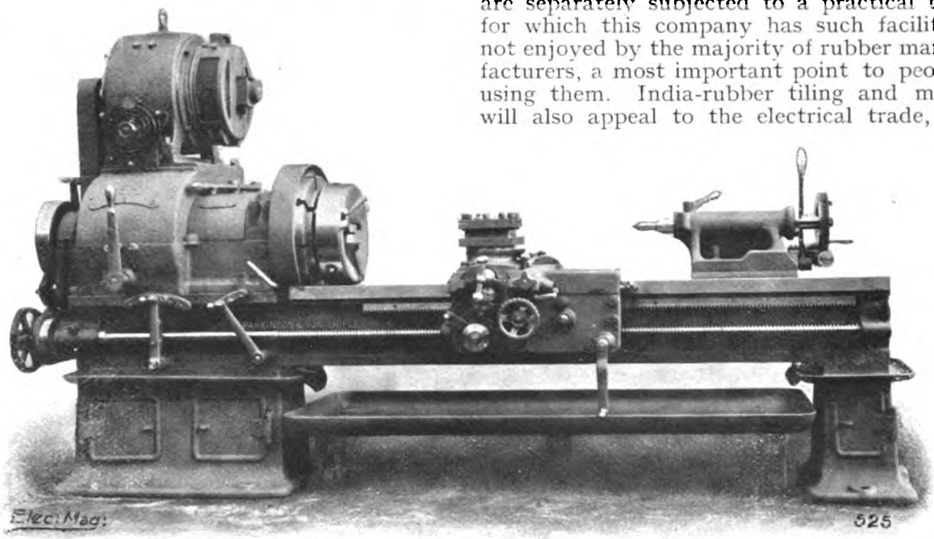
The machine has two ball-bearings taking up the thrust of the friction-pulley, and the



STAND OF THE INDIA RUBBER, GUTTA PERCHA AND TELEGRAPH WORKS COMPANY BRADFORD EXHIBITION.

drill-thrust respectively. The drill table can be raised, lowered, or swivelled as required. The motor is wound for all standard voltages for 100 to 230.

An attractive yet instructive feature of the stand is the "Phœnix Egg," a large aluminium egg spinning in a wooden dish, below which is a circular coil coupled to a 3-phase circuit. The "egg" tends to follow the rotary magnetic field of the coil, and rising on its point spins gaily, affording a simple yet lucid example of the induction motor principle. The stand is identified at night by a large "P.D.M." sign in coloured lamps, hung high above the exhibit, while another attraction is a small fountain worked by the 3-throw pump mentioned above, the interior of the water column being lighted by coloured lamps. The company also exhibits its a.c. and d.c. motor starters, several of which control both types in operation on the stand. For further details of the companies' manufactures we refer the reader to page 71. Some twenty "P.D.M." motors totalling 208 b.h.p., both alternate and direct current, are in use about the exhibition, driving textile machinery and machine tools.



Parkinson 8½-in. Centre Electrically Driven Lathe, at Bradford Exhibition

The India Rubber Gutta Percha, and Telegraph Works Co. Ltd.

The Company is perhaps better known in the electrical world as the "Silvertown Company," and they make a comprehensive exhibit of their manufactures at Stand 103, of which we give an illustration. The most interesting to electricians is one of their 10-horse-power motors of the open protected type. This is also made semi-enclosed and fully enclosed as desired.

A quantity of india rubber insulated cables for electric lighting are on view, and the Silvertown Adhesive Compound Tape, which is done up in tin enamelled boxes, making it handy to carry in a workman's bass without being damaged by dust, is also shown. In addition there are their celebrated Leclanche cells and bell wire. They also show specimens of Submarine cables made and laid by them by their own ships in all parts of the world. Another item of interest to the electrical engineer is their india-rubber gloves. All the gloves specified "electrically tested" are separately subjected to a practical test for which this company has such facilities not enjoyed by the majority of rubber manufacturers, a most important point to people using them. India-rubber tiling and mats will also appeal to the electrical trade, as will ebonite rods and sheet also gutta-percha manufactures for electrical purposes. There is also a good showing of india-rubber in the form of sheet, roller covering, washers, &c.

J. Parkinson & Son.

This firm has a fine exhibit of lathes, among which we noticed an electrically-driven type with 8½-in. centre and 5-in. hollow spindle. We give an illustration of this machine, in which the motor, a "P.D.M." 4 b.h.p., can be easily distinguished.

These lathes are designed for heavy bar work, the spindle having a hole five inches in diameter through its entire length. The face plate gear is bolted direct to a flange on the spindle, thus reducing the torsion on the spindle when driving through the double gears. There are six speed changes by gears, in the headstock for each motor speed, and with three speeds of the motor, eighteen spindle speeds varying in geometric

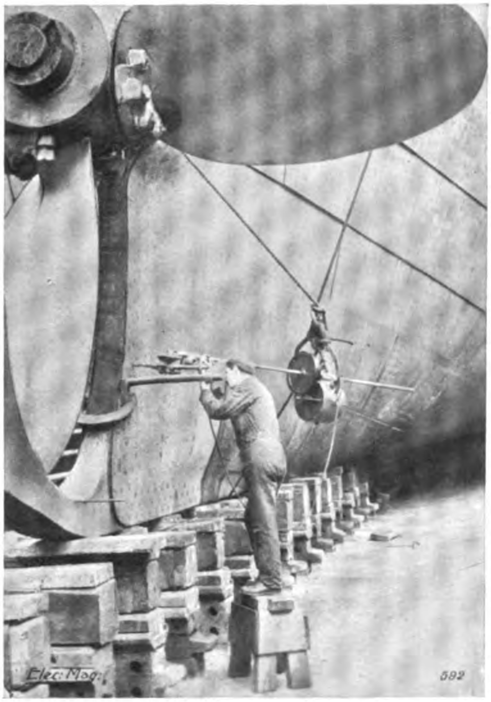
progression from 6.6 to 299 revolutions per minute, are obtained. The speed changes in the headstock are controlled by conveniently placed levers, and the speed regulation of the motor is also easily manipulated.

The drive from the motor to the headstock, is through a Renold silent chain, and by the introduction of a friction-clutch between the driven chain wheel and the lathe headstock, it is possible to stop the lathe without stopping the motor and to start the lathe gradually with the load on and the motor running at speed. This arrangement also greatly facilitates the setting of work and the gripping of bars in the chuck, as it affords a ready means of rotating the spindle for a portion of its revolution. A hand-wheel is also fitted on the same shaft as the clutch, by means of which the spindle may also be rotated by hand. The chuck shown in the illustration is a 16-in. diameter 3-jaw spiral chuck with $5\frac{1}{4}$-in. hole. The bar is also steadied by four screws arranged in a plate at the rear end of spindle. It will be noticed that all the gears are carefully guarded by covers, but these are removable for purposes of lubrication.

The sliding, surfacing, and screw-cutting movements are identical with those usually fitted to this firm's high-speed lathes. The sliding and surfacing feeds are reversed by turning a knob on the apron. There are eight rates of feed, positively driven with quick change handles, and these range from 8 to 240 cuts per inch, the finer feeds being intended only for cutting off and boring.

In place of the usual swivel slide-rest, a four-tool turret is fitted on the cross slide. The base is graduated in degrees so that tools may be set to any angle, and the turret is rotated and held in any desired position by worm and wheel, and locked by central bolt. If required, however, a slide-rest, to be clamped in the turret in place of one of the tools, may be furnished. This is intended for angular work, either external or internal, after roughing out with an ordinary tool. A special cutting-off tool holder is also furnished as an extra, the section of the blade being $1\frac{1}{2}$ in. × $\frac{3}{16}$ in.

The loose headstock may be furnished with power feed drive from the back shaft, as shown in the illustration, thus enabling holes to be bored whilst the external diameters of the work are being turned. For use in conjunction with this, a drill guide may be supplied; this is pivoted to the back of the saddle and swung in or out of position as required. As shown, the standards are provided with channels for conveying the cooling fluid that may drip from the gantry to the drop pan under the lathe. Pump and circulating pipes are not shown in the illustration, but can be supplied if



PORTABLE ELECTRIC DRILL IN USE ON SHIP'S STERN.
(*Shown by United States Metallic Packing Co.*)

required. The usual travelling and stationary stays are furnished, and the live spindle is coned at the front to receive the bush which carries the ordinary conical centre, thus rendering the lathe adaptable for ordinary turning between centres.

The motor is a 4 b.h.p. shunt wound, with variable speed control, a shunt resistance permitting a speed variation between 640 and 1000 revolutions per minute. The drop pan under the lathe is included in the price, but chucks are extra.

DIMENSIONS.

Height of centres .	$8\frac{1}{2}$″
Length of beds . .	10, 12, and 14 ft.
Admit between centres	4′ 10″, 6′ 10″, and 8′ 10″
Swing over bed . .	$17\frac{1}{4}$″
,, ,, saddle .	$10\frac{3}{4}$″
,, ,, gap . .	36″
Gap	$9\frac{3}{4}$″ deep × 1 ft. 3 in. wide.
Width across face of bed . . .	14″
Hole through spindle .	5″
Diameter of front bearing . . .	7″
Length . . .	7″
Quick change positive gear foods . .	8, 16, 32, & 48 cuts per in. for sliding, and 40, 80, 160, 240 for cutting off and boring.

The Frictionless Engine Packing Co. Ltd.

This well-known firm occupied a prominent position in the Industrial Hall. They exhibited on their stand a number of their specialities, among which their Karmal Engine Packing was of particular interest to engineers. This packing is claimed by the makers to be practically frictionless, its lubricating qualities continuing so long as there is any fibre of the packing left. From samples inspected the statements of the makers would seem to be fully borne out. The packing requires neither oil nor tallow, and considerable time and expense are saved by this feature. The packing is made for pressures from 80 to 120 lbs. Among the other specialities on view we may mention Roko belting and belting Accessories. The elevator on the Water Chute is being driven by one of this firm's belts, and it is entirely impervious to moisture. It is of the same make as that which gained the gold medal at Paris in 1900.

The United States Metallic Packing Co. Ltd.

This old-standing firm made a very fine exhibit of their chief specialities in the way of metallic packing, portable drills and reamers, and pneumatic chipping and caulking hammers. There is also on view a packing which, after fifteen and a half years' service, is in practically the same condition as when applied, this being exhibited to illustrate the extreme durability of the packing after years of working. We may mention that this Company's packing will be used in the Musgrave engines shortly to go down in the East Greenwich Tramway Station of the London County Council. The portable electric drill is an extremely valuable device, and we depict one herewith (p. 81) at work on a ship's hull. We understand that a quantity of these drills are being employed by the Admiralty in the Portsmouth, Chatham, and Devonport dockyards. Messrs. Hadfields of Sheffield have also a number in service drilling rails for their tramway lay-outs.

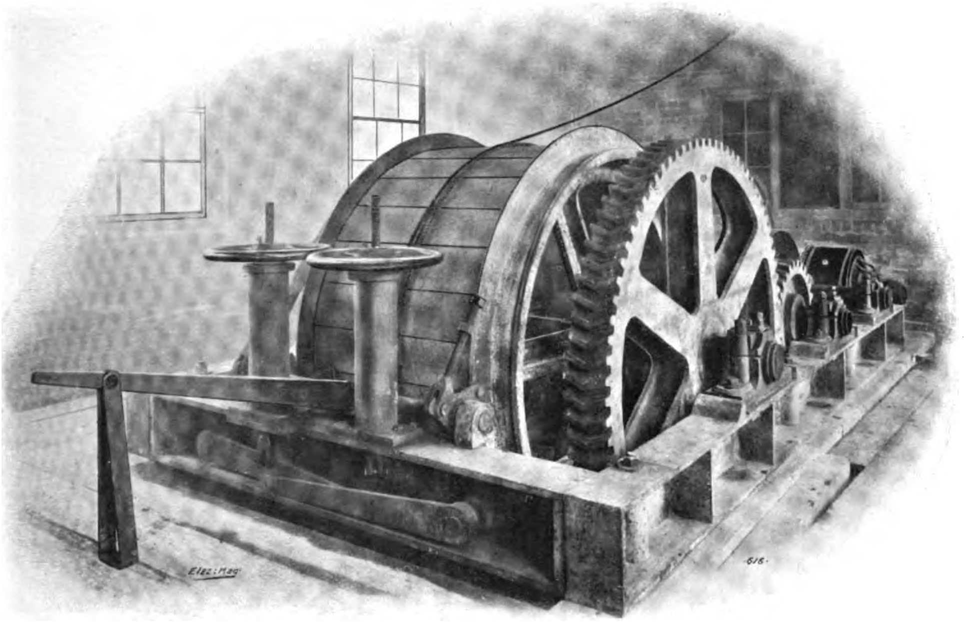
There are a number of exhibitors of fans, among whom we may mention The Sun Fan Co. Ltd., Matthews & Yates, Ltd. (whose fans we referred to in our Manufacturers' Section last month), and J. Stott & Co. The British Westinghouse Co. have a small stand, on which a number of direct and polyphase motors are displayed. This firm has installed quite a quantity of plant in the Bradford district, notably to the Bradford Dyers' Association, and Sir Titus Salt, Ltd., Saltaire. The National Telephone Co. have a good exhibit, and there are several motors by various firms driving small machinery in the Industrial Hall. Among these are motors by the Rhodes Electrical Manufacturing Co. and J. H. Holmes & Co.

The Phœnix Dynamo Co.'s stand has an exhibit of Edgar Allen & Co.'s steel. Messrs. Green & Sons have a small model of their economiser in operation, and a full size section of an air heater and drier for placing in the boiler flues, the necessary heat being obtained from the boiler flues in which the tubes, resembling those of the firm's well-known economiser, are placed. A small fan is shown in operation driving air through the tubes exhibited.

The exhibition is lighted by Brockie-Pell arc lamps to the number of about two hundred, suitably placed throughout the grounds, and the various buildings. In the Concert Hall is a large fountain, which is turned on at night, and illuminated with various colours from arc lamps arranged directly above it. This is quite an attraction and is well patronised.

ELECTRICITY AT THE INTERNATIONAL COLLIERY EXHIBITION, 1904.

THE opening of the Second International Colliery Exhibition on June 25 last, by Sir Lees Knowles, Bart, M.P., at the Agricultural Hall, should mark a distinct era in the history of electric power in its application to colliery work. Coming as it does directly upon the issue of the Report of the Electricity in Mines Committee it should do much to impress colliery men in this country with the many advantages which electricity possesses when utilised in and about the workings of a mine. The many and varied operations necessary to coal-getting can be better performed by the agency of electric power than by any other means, and in the application of machinery at the coal face and in the workings it is safe to predict that had not compressed air and steam been previously tried, electricity would have carried everything before it. Space will not permit us to dwell at length upon the many advantages conferred by the use of electricity in mining, and we must leave it to our readers, and especially those

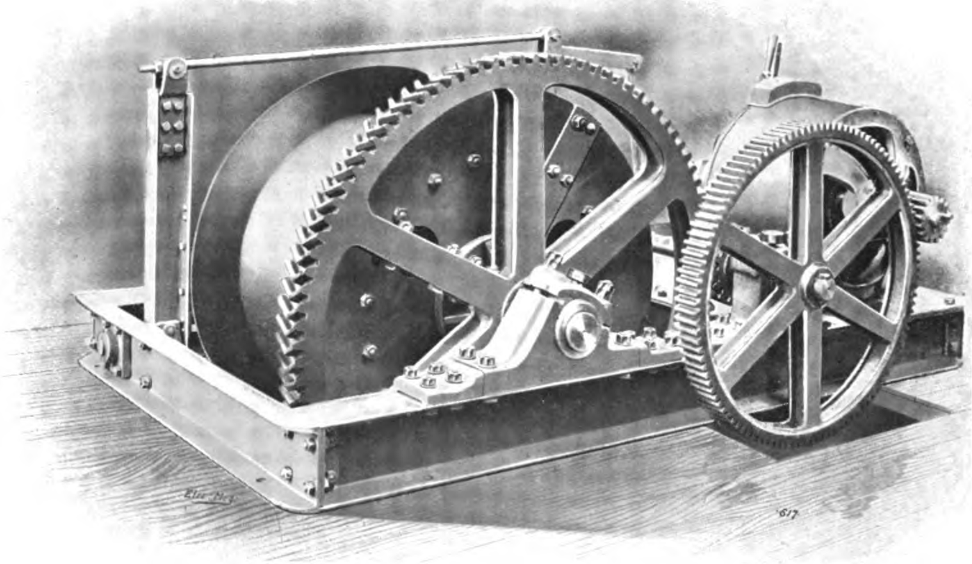


ELECTRIC WINDING ENGINE.
(*General Electric Co.*)

who are colliery proprietors and managers, to judge for themselves of the work electrical engineers are doing in this important sphere. Much has been said upon the backwardness of colliery men in this country in availing themselves of modern methods such as are embodied in electrical operation, and we ourselves have pointed to the work of Continental manufacturers in the series of articles from the pen of Mr. P. R. Allen, in which full prominence was given to some important work of this character carried out by enterprising German firms. At the same time we have made due allowance for the greater length of time in which British mines have been working, and the difficulties to be overcome in persuading proprietors to abandon old plant for, to them, costly experimental machinery. The work of conversion in this country has been, and will be, a harder task than American or Continental managers have experienced, though but a brief glance is needed at the work done, to indicate that progress, though apparently slow, is nevertheless sure. The increasing activity of power companies, the standardisation of apparatus by manufacturers, the facilities for procuring reliable transmission cable, and the perfection of a hundred and one other electrical details, now render the work of equipping a mine with electrical apparatus a comparatively simple matter. In addition, the Report of the Electricity in Mines Committee, with its recommendation of three-phase working and many rules, impresses the work with the mark of authority, while affording colliery men that safeguard which, as engineers and not electricians, they require.

We present our readers with a few typical illustrations of the apparatus exhibited, and have selected these in preference to photographs of the mere exhibits as likely to appeal more to colliery men. Electricity was well represented at the Exhibition, and many firms of considerable experience in applying electrical apparatus to mining work were open to consultation. In the majority of cases their recommendations could be backed up by practical examples of their designs, a number of which were in operation.

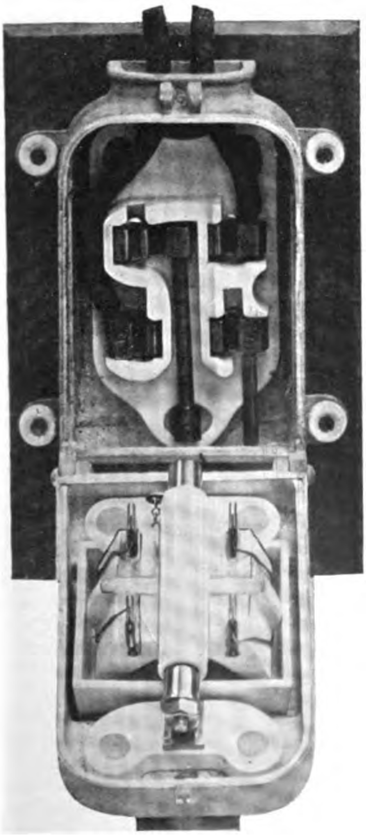
The General Electrical Company, Queen Victoria Street, London, E.C., were the only firm exhibiting a generating set in operation supplying current to a number of motors, &c. The exhibit comprised a 200 kw. 3-phase steam alternator (Howden engine), supplied with steam from a large Stirling boiler fixed on the adjoining stand. A main and tail portable hauling gear, a single drum portable hauling gear, and a portable pump, were shown in operation, driven by 3-phase motors. A single drum hauling gear, driven by a 75-h.p. motor, was also exhibited with the necessary switch gear. In addition there were a number of motors, motor switches, mining telephones, bells, and



Electric Hauling Engine.
(*General Electric Co.*)

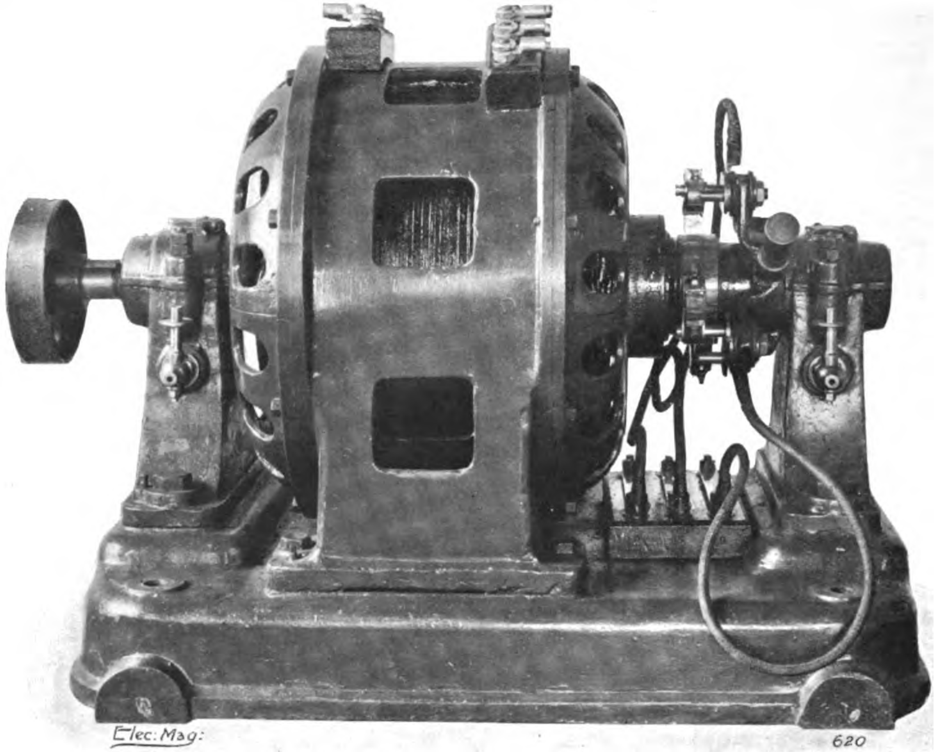
keys, magneto exploders, &c. The Company had issued a handsome pamphlet, which should make very interesting reading to colliery men. In it the entire aspect of the situation is reviewed in detail, and the work of the Company illustrated and described. The portable pump plant was an interesting feature of the exhibit, the 3-throw pump being arranged on an incline, economising ground space. Where every inch below ground has to be cut out, sometimes through solid rock, the advantage of such a pump becomes at once evident, especially considering that additional headroom is not required. An inset to the pamphlet stated that the Company had perfected a system of polyphase motors in which rubbing contacts were entirely avoided, starting, stopping, and control being effected entirely in the primary circuit. Full particulars of this system can be obtained from the Company upon application. The British Westinghouse Electric and Manufacturing Company, were in full force with their standard electrical mining apparatus. A vast amount of work has been done by this Company in British mines, and the exhibit was laid out in the body of the Hall in a prominent position which could not well be overlooked In addition to a number of standard motors, which are now well known, the Company exhibited a 20-h.p. polyphase motor coupled to a Markham haulage gear. There were also several types of oil-starting switches, which are now practically indispensable in fiery mines. Ernest Scott & Mountain, Limited, Newcastle-on-Tyne, occupied a good position in the body of the hall. They exhibited a 3-bearing 3-phase 100 kw. alternator with rope pulley and belt driven exciter. Types of the Company's 3-phase and continuous current motors were on view, and a Scott & Mountain disc coal-cutter of a new type with 25 to 40 h.p. motor. Their work in this country is fully described in an instructive pamphlet issued by the firm and given away on the stand. Mavor & Coulson, Limited, Glasgow, made a good showing with their Pickquick (Hurd's Patent) coal-cutting machines, and motors for driving the same, together with a quantity of accessories. These machines were described in our February issue, page 198. John Davis & Son (Derby), Limited, had a large stand fitted up with their well-known mining specialities, examples of almost every type being on view. The chief items of electrical interest were a portable single drum hauling gear driven by a 10-h.p. motor, electric coal and rock drills, and coal-cutters. We must also specially refer to the firm's accessories in the shape of switchboards, junction, switch and fuse boxes, starting switches, telephones and signals specially designed to comply with the suggestions of the Electricity in Mines Committee. Messrs. Davis, as our

readers will doubtless be aware, were among the pioneers of electrical mining work in this country. Bruce Peebles & Company, Limited, Edinburgh, had a conspicuous stand at the end of Row C. This comprised a 240-h.p. 3-phase 3000-volt induction motor, patent single reduction gear with 3-phase induction motor, and a number of the Company's specialities in electrical apparatus. The high-tension induction motor mentioned above is of particular interest in that the use of this class of apparatus connected direct to the transmission leads, renders the electrical plant very efficient in operation, as costly transformer devices are unnecessary. Seeing that satisfactory H. T. transmission cables are now procurable practically no difficulty is presented in the use of the generating pressure direct at the motor terminals. The Diamond Coal Cutter Company, Wakefield, made a special show of their "Longwall" disc coal-cutting machines, driven by 3-phase and continuous current motors. With this machine the motors are arranged at each end, and drive the cutter



Callender Ward Fuse Box—Open, showing Fuses.

wheel through suitable gearing. A single motor type was also exhibited suitable for working short or uneven faces to hole 4 ft. 6 ins. only. Witting, Eborall & Company, Limited, Temple Bar House, London, E.C., exhibited various specimens of their motors, drums, and switch-gear, also an interesting type of compounded 3-phase generator (p. 86). This is a synchronous machine with special field winding, into which 3-phase exciting and compound currents are led from a small special commutator. The field system is applied to the design of Mr. A. Heyland, the generator being compounded both with regard to the amount of the load and the power factor. The machine exhibited had an output of 140 volts and 41 amperes per phase running at 1400 r.p.m., the periodicity being 40 cycles. The machine will give a 10 per cent. increase of pressure from no load to full load for a non-induction circuit, and will keep the pressure constant for a purely inductive load. There were also specimens of polyphase motors fitted with internal resistance and short circuit device as described in Mr. W. Buechi's article on page 11 of this issue. There was in addition a 500 kw. 7000 volt oil switch. At the stand of Messrs. Reavell & Company, Limited, Ipswich, there were a number of electrically driven air compressors, which are now well known as the speciality of this firm. The chief machine was a large direct coupled double-ended air compressor, with the motor placed between the compressors. This machine is extremely compact, and highly efficient, owing to the absence of gearing. The machine was shown with one end at work, and the other open, with parts withdrawn for inspection. Other exhibits on the firm's stand comprised a small unjacketed duplex electrically driven compresser, shown at work, and supplying air for a model coal-cutter on the Champion Channelling Machine Co's stand near by. The exhibit of the Electrical Company, Limited, Charing Cross Road, London, W.C., consisted of a picture gallery, in which a number of large and excellent photographs of electrical mining machinery were shown. These depict a quantity of apparatus described in Mr. P. R. Allen's articles, and now well known to the majority of our readers. A speciality of the firm is its electric winding engines, which have been built in very large sizes, and are in extensive operation on the Continent. The stand of the Lahmeyer Electrical Company, New Oxford Street, London, W.C., was fitted up in a similar manner with large photographs, and depicted some very fine examples of electrical mining apparatus on a large scale. A quantity of the firm's motors were also on view. The Worthington Pump Company, Limited, Queen Victoria Street, London, E.C., made a fine showing



COMPOUND THREE-PHASE ALTERNATOR.
(*Witting, Eborall*)

with their well-known pumps and air compressors. A feature of the stand was a large 6 in. 3-stage centrifugal turbine pump, driven by a 50-h.p. Westinghouse induction motor. In a succeeding issue we shall give an illustrated description of this pump. An interesting disc coal-cutter was exhibited among other appliances by Clark Steavenson & Company, Limited, Barnsley. This machine is of an improved type, and driven by a single 3-phase or continuous current motor fitted with special worm gear. The machine shown was capable of under cutting 5 ft. 4 in. Other exhibitors of electrical apparatus were the Ingersoll Sergeant Drill Company, F. A. Glover & Company, Limited, the Roburite Explosives Company, Limited. and Griffiths & Biliotti.

The Cable Companies were much in evidence, and a fine exhibit was that of Messrs. Callender, who exhibited almost every class of cable wire required in colliery work. A model was on view of the method of suspending and making joints on cables in shafts. A speciality is made of colliery cables, and among these we may refer to a patent fall-resisting cable, armoured with lock rail wires, and single galvanised steel wire, with which it is impossible to displace the wires of the lock coil armouring. Joint and dis-connecting boxes were also on view. the fittings of which embody the latest practice in contacts and fuse-holders. A special trailing cable for coal-cutter work was shown, protected with a solid leather sheath. The St. Helen's Cable Company were in force with their cable specialities on a large stand, prominence being given to Dialite Cables of every description. To illustrate the insulating properties of the substance, a Dialite Cable was shown working in boiling water, the same cable supplying the lights for the stand. As the cable has no lead cover, it is quite unaffected by chemicals in the water so often found in mines. A special switch-box was on view, but as our space is limited we shall refer to this in a future issue. W. T. Glover also made a good showing with their cables, among the samples being a type of fire-resisting cable for colliery work.

The Mechanical Stoker firms made a fine effort in showing their specialities, but we must refer our readers to Mr. Whysall's article in the Central Station Practice Section for details of these.

The World's Electrical Literature Section at end of Magazine contains a classified list of all articles of interest to Central Station men. Consult it and save yourself much valuable time.

Mechanical Stokers.—II.

By F. H. WHYSALL, A.I.E.E.

(Concluded from page 648.)

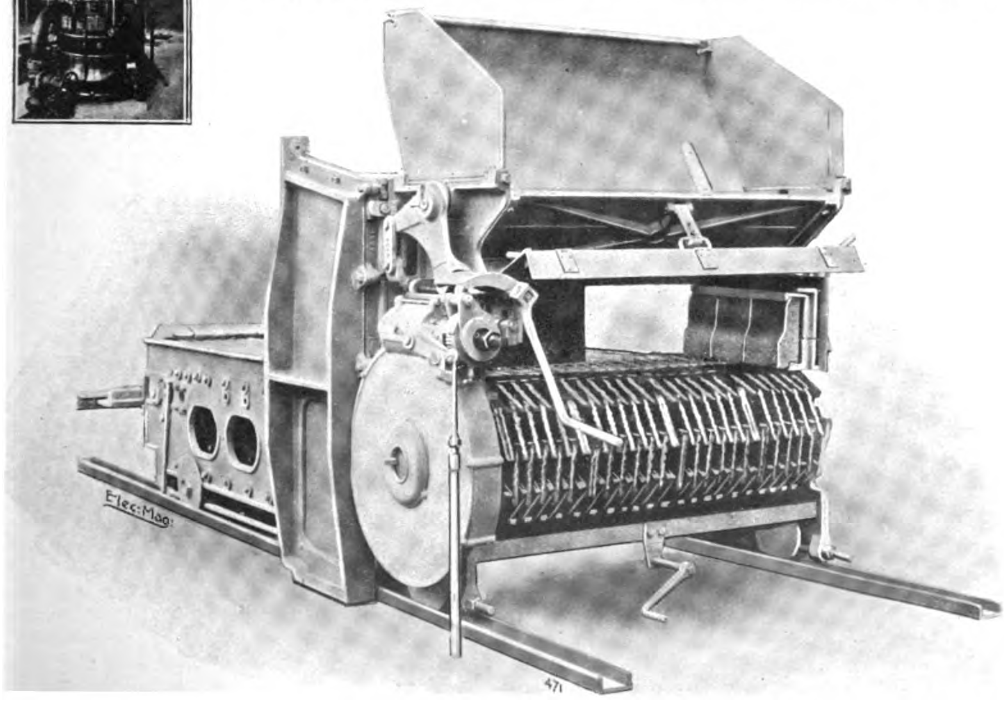
Coking Stokers.

Babcock & Willcox Chain Grate.

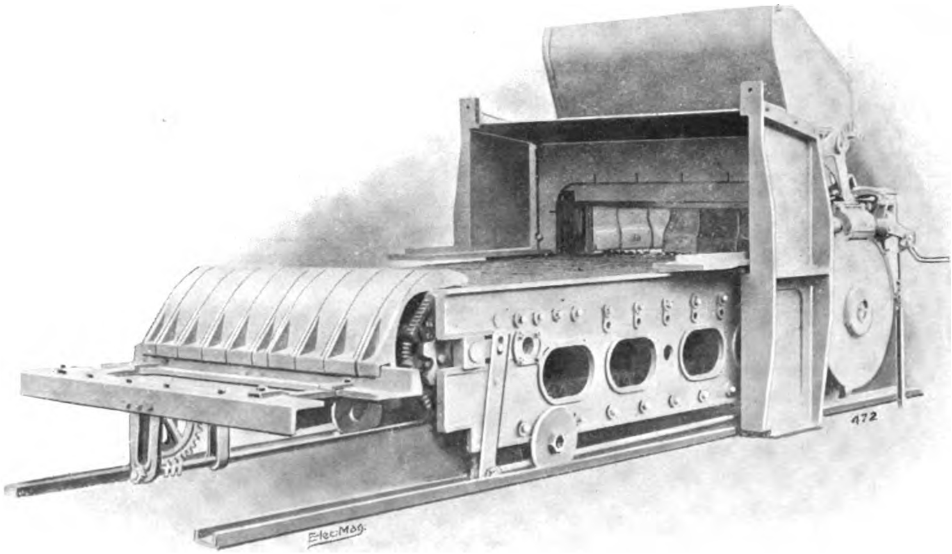
THIS stoker is designed for the efficient and smokeless combustion of semi-bituminous fuel. The grate consists of an endless chain of short cast-iron grate-bars, linked together, passing over drums at front and rear, the front drum being revolved by a worm and wheel.

The coal is fed over the whole width of the grate, the depth of the fire being regulated by adjustment of the vertically lifting fire-doors. The feed of the coal is slow, and the gases evolved from the fresh fuel pass underneath a highly heated firebrick arch over the incandescent coal, and complete their combustion before coming in contact with the boiler heating surface.

The fuel is gradually consumed as the



BABCOCK & WILLCOX CHAIN GRATE STOKER



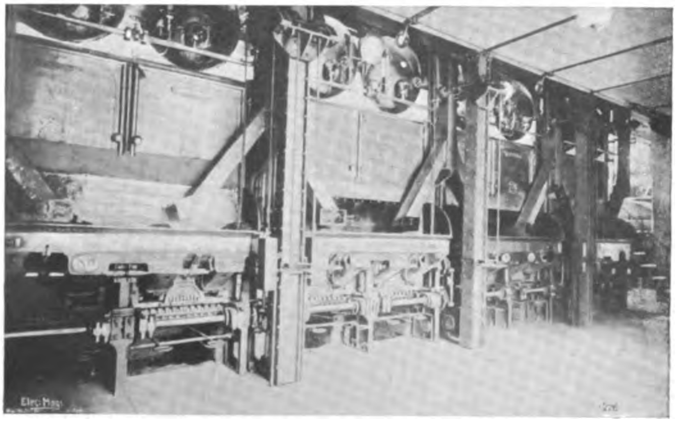
BABCOCK & WILLCOX CHAIN GRATE STOKER.

(*Back view.*)

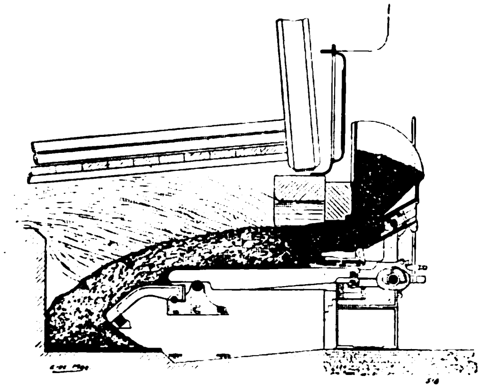
grate travels on, and when the dumping-bars are reached, there should be only ash and clinker left. These in passing over the dumping-bars fall into a receiving-pit provided with a hinged bottom, which is opened when required to allow the clinker to be removed.

The depth of the fuel and the speed of the grate can be adjusted in a moment to suit the conditions of draught available, the class of coal to be burned, and the evaporation required. The stoker can be driven from a shaft either overhead or underground. It can also be worked by hand, by a crank placed on the end of the worm-shaft. Should the working of the stoker from any course be temporarily affected, hand-firing may be resorted to at a moment's notice.

T. & T. Vicars.—The Vicars coking stoker is so well known that a few remarks will suffice to indicate its chief points. The section through a furnace reproduced herewith, shows the latest pattern stoker attached to a water tube boiler and the photo illustrates a battery of similar boilers at Dickinson Street Station, Manchester, fitted with the Vicars stoker. The coal is moved down the grate by the motion of the fire bars, from the "dead or coking" plate at the hopper end. The feed-rate can also be regulated at will. With the latest pattern the ordinary arrangement of boiler can be maintained, no brickwork is used to seal the stoker to the boiler, and no holes are drilled in the boiler front plate, the stoker being entirely supported from the ground. In addition the stoker can move on its supports with boiler contraction and expansion, no dropping can take place at the centre where ample support is provided, and the bars can be worked by hand if the motor or engine breaks



VICARS' STOKERS AT MANCHESTER ELECTRICITY WORKS.



SECTION THROUGH VICARS STOKER.

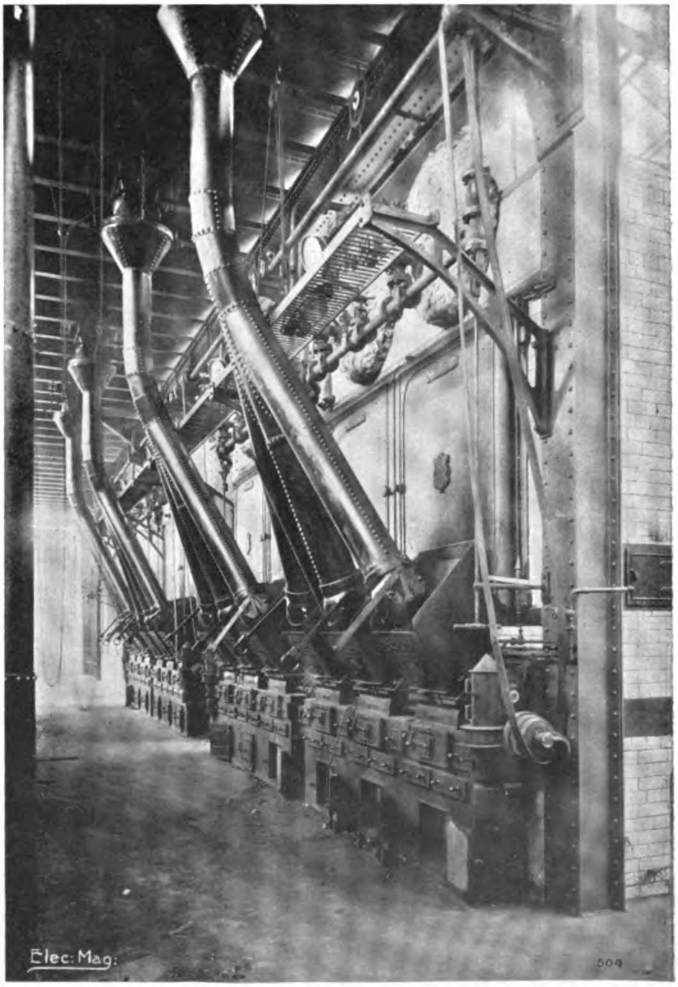
down. The bars and cross-trees can be removed without taking out shafts or dead-plates and all wearing parts are removable independent of the main castings.

James Hodgkinson, Salford.—These stokers are simple and efficient. They have few working parts, and are designed with an eye to reducing first cost and upkeep as much as possible. The makers manufacture stokers of the sprinkler type also, but do not claim as much for them.

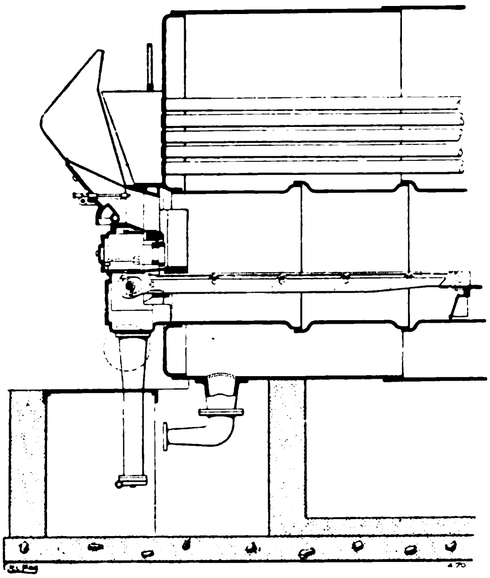
A special feature of these coking stokers is suitability for induced draught and forcing. They will work equally well on any class of boiler, are neat in appearance and leave the boiler front clear for the usual mountings. They occupy little space and are so constructed that hand-firing can be resorted to without delay or derangement. Illustrations of the stoker as applied to a Lancashire boiler are shown, also a photograph of an installation of these stokers at the Salford Electricity Works.

Meldrum Bros. Ltd., who have done so much for refuse destruction, make a coking stoker the special points of which will be easily gathered from the illustrations. It is widely used, and has proved quite satisfactory in operation. It differs materially from others in that its ram consists of a sector (see illustration, p. 90) working on a pivot, instead of being flat and sliding backward and forwards. The bars are made with an undulating surface, so that the reciprocal motion of adjacent bars prevents the adherence of clinker. As a proof of the comparative coolness of the fire-bars, it may be mentioned that no difficulty is experienced in lubricating the ends. Steam-blowers with superheated steam are used with this stoker, for the double purpose of forced blast and cooling the bars. Where forcing and heavy duty is desirable these stokers are found very satisfactory. The adjoining photograph depicts the stokers as used at the Temple Back Electricity Works of the Bristol Corporation.

The Underfeed Stoker Co.—This firm makes the Underfeed Stoker, which is of the screw type. It consists of a hopper or receptacle for the fuel, the base of which



MELDRUM STOKERS AT BRISTOL ELECTRICITY WORKS.

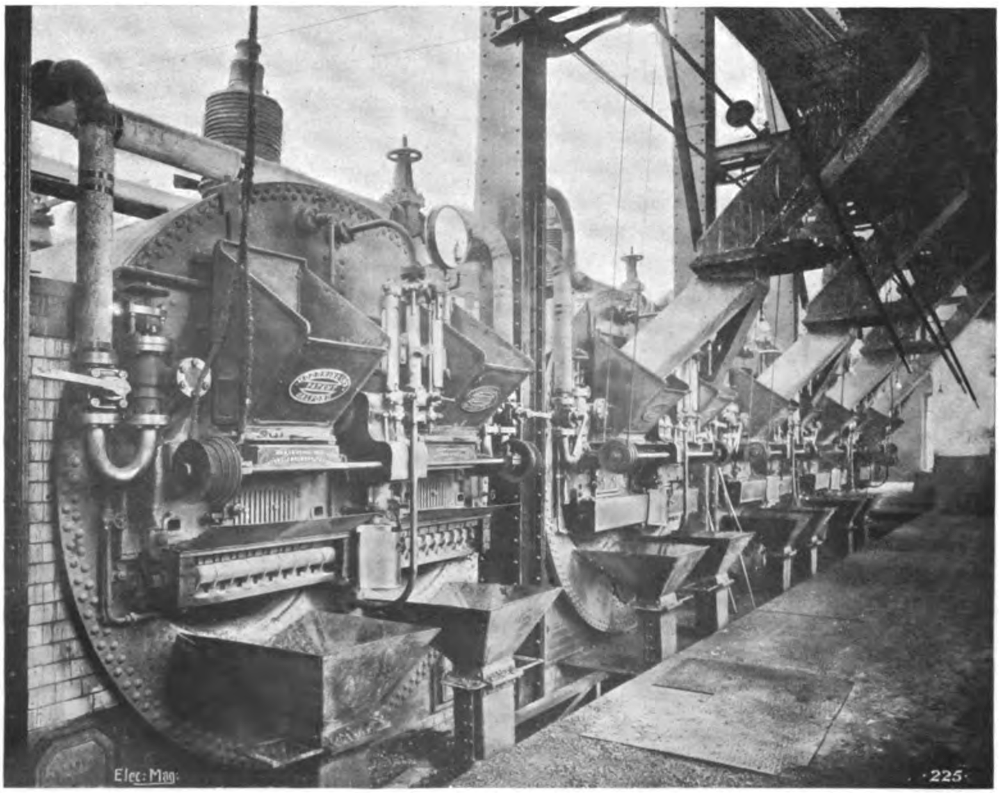


Section through Meldrum Stoker.

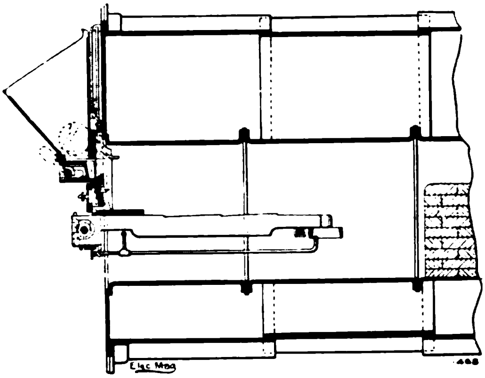
communicates by means of a pipe with a horizontal trough or combustion retort within the furnace of the boiler. This trough or retort contains a screw or worm conveyor actuated by a small steam-motor placed in front of the hopper. By the rotation of the worm the fuel is advanced from the hopper into the retort, filling it with coal, which overflows upon terraced grate-bars at the sides, in a rounded mound. Air for the combustion is introduced below these grates and through tuyere orifices along the inside of the retort at a point near its top.

Erith's Engineering Co. are makers of an interesting form of underfeed stoker, a section through which is given herewith. The coal is fed from below by a steam ram, which forces up fresh charges of coal at regulated intervals, an automatic trip-gear being employed to admit and cut off steam. The ashpit is completely closed from the fire by solid dead-plates and a fan draught is employed. The air delivered by the fan fills the enclosed space and passes to the fire through the removable tuyere blocks lining the coal retort.

It will not be out of place here, having given a description of two types of underfeed stoker, the Erith Ram-feed and Under-



Hodgkinson Stokers at Salford Electricity Station.

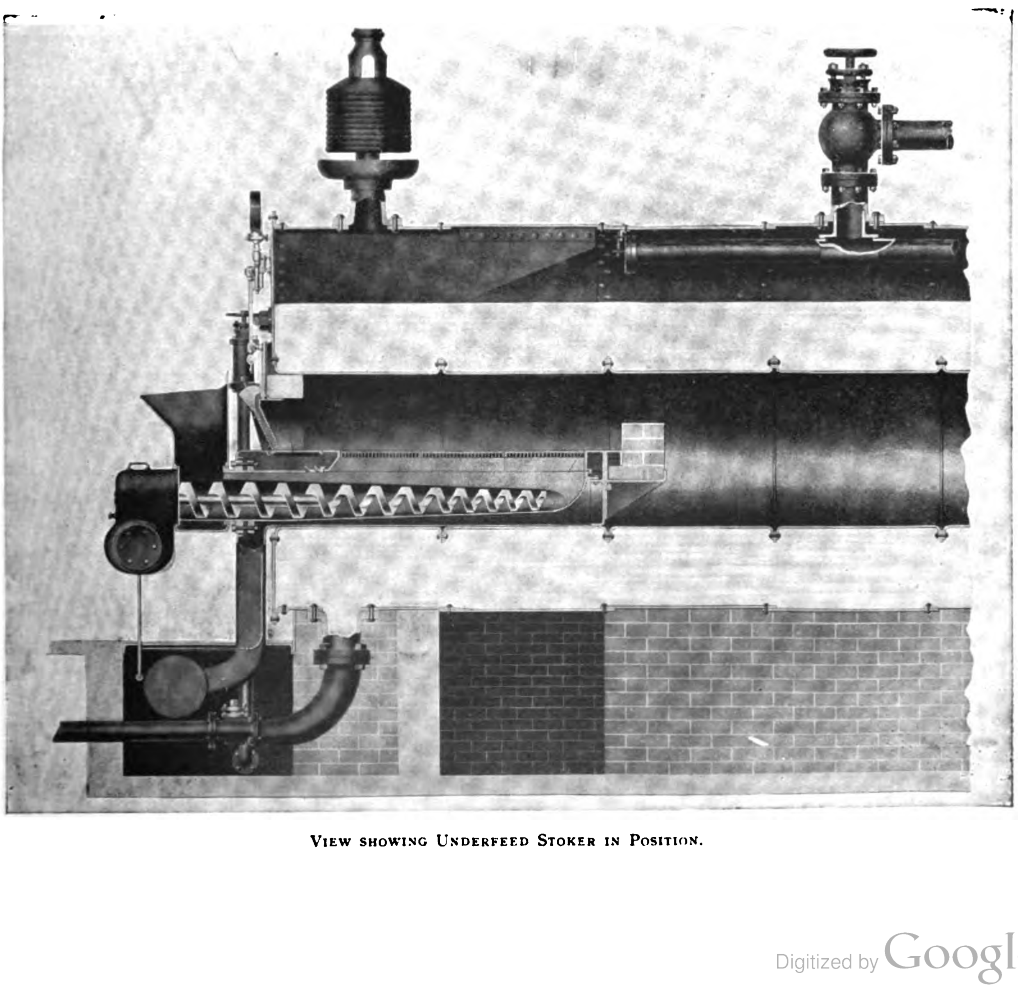


Section through Hodgkinson Stoker.

feed Screw-feed, to enlarge somewhat on the points of underfeed stokers as compared to other types.

In the ordinary practice of burning coal upon grate-bars, it is usual to throw the fresh fuel required for the maintenance of the combustion upon the top of the fire. This may be done by hand or by mechanical devices, but with essentially similar results. The green coal falling suddenly upon an incandescent mass of glowing fuel discharges combustible gases with great rapidity, imperfect combustion is likely to take place and smoke made. The fires are alternately bright and clear, dull, and if not fired carefully, smoky. In the underfeed stoker the fresh fuel for the maintenance of combustion is supplied from below the level of the fire and gradually advanced upward towards the zone of combustion. The effect of this method of feeding is to keep a perpetually clear, bright surface of incandescent fuel, which, while always producing its maximum steaming effect upon the boiler, is also gradually heating and coking the green coal coming up from below and causing it to slowly give off its combustible gases. As these can only escape by rising through the incandescent coal above, and being mixed with air from suitable tuyeres they are at once completely consumed, and a clear short flaming fire results.

In the ordinary coking stoker the coal is ignited at the front end of the furnace and quite as much is said for this method with



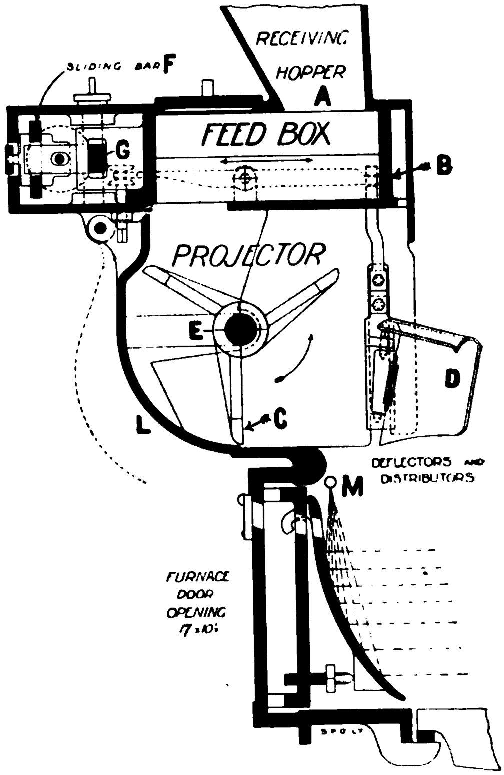
View showing Underfeed Stoker in Position.

regard to complete combustion as for the underfeed, with, in the case of the ordinary coking stoker, the advantage claimed that it is self-cleaning. To set against this last item is the tendency of the fires in the ordinary coking stoker, to get thin at the back although thick in front. The leading remarks about ordinary methods, of course, apply to sprinkler stokers, as imitators of hand-firing, but I think it is rightly claimed that sprinklers will deal best with low-grade fuel.

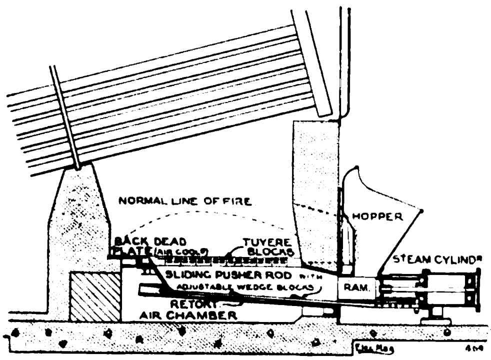
The E. S. E. Stoker.—Though essentially a sprinkler stoker, the "E. S. E." stoker, which is rapidly coming to the front, is worthy of notice here. Revolving projectors are used to throw the fuel against deflector plates, which very effectively distribute it over the entire grate. The method of feeding the fuel conforms to the desideratum in mechanical stoking mentioned in the previous article, *i.e.*, "feeding small quantities at regular intervals," and possesses the further merit that the fuel is uniformly spread alternately first into one (longitudinal) half of the grate, and then into the other, thus in all respects imitating the best hand-firing without its inherent drawbacks. The method of operation will be readily understood on reference to the adjoining diagram. This stoker is also made with moving grate-bars, which very effectively prevent the adhesion of clinker and traverse it to the bridge-end of the furnace, where it drops into a pit and can thence be periodically removed. The "E. S. E." Patent Mechanical Stoker is made by the Smoke Preventer Company, Ltd., Blackburn, who are well known for their specialities in connection with fuel combustion.

To conclude. The writer would advise steam-users to consider well the following points before deciding on any particular form of mechanical stoker.

Local Conditions.—Such as : quality of fuel obtainable, distance from source of supply, attitude of local authorities to smoke nuisance, want of space or otherwise, transport facilities.



E.S.E. Stoker. Section through Feed-box.



Section through Erith Ram Stoker.

Requirements.—Most essential to their case : smoke consumption, increased duty, or cheaper fuel and economy of working, or further if it is desired to have better regulation to meet a fluctuating demand.

The remaining considerations of prime cost, simplicity of construction, ease with which spare parts can be obtained and fitted, will be taken as a matter of course and decided by studying the makers' catalogues. Results of tests have been purposely omitted owing to the difficulty of obtaining a common basis of comparison.

Mr. Cleary's article on Underground Mains is held over until the next issue.

Central Station Engineers *should use this section as a medium for the interchange of ideas on all matters relating to the installation, maintenance and repair of the plant and mains under their control.*

If you have an idea *for the better management of any central station department, or for any improvement in operating, send us a description of it.*

We supply the Magazine on special terms *to central station men. Write for details.*

Notes on the Working of Central Station Plant.—II.

By F. H. CORSON.

(Continued from page 630.)

Concerning the Working of Boilers.

Most Station Engineers agree on the wisdom of frequently indicating their engines, to be assured that each unit is maintaining its efficiency, but very few are inclined to take the same trouble with their boilers, although the loss incurred by uneconomical work from a boiler greatly exceeds that due to any probable deterioration on the part of a generating set. The CO_2 record may be regarded as the Indicator diagram of the boiler-house, and gives a good idea as to whether the boilers are working under conditions conducive to the best results. At the same time the achievement of a good record as shown by the apparatus is not an absolute guarantee against waste of coal. A high percentage of CO_2 shows that the coal *burnt* is doing good work, but does not necessarily indicate the complete combustion of all the coal supplied. Certain bituminous coals are inclined to clog, forming masses of caked fuel to which air has no access, and which are often carried over the grate unburnt or cleaned out with the clinker. If this tendency is present, all the ash must be examined, and any fuel which is coked but not thoroughly burnt, may be used either alone, or mixed with the fine ashes which drop through the bars, for banking fires, or even for steaming a working boiler under easy draught.

This defect is much more likely to occur with mechanical stokers than with hand firing, and the writer has found the ash which has been carried over the bars into the back pit, to have had in some cases, a calorific value of over 6000 British thermal units, thus representing an enormous waste of fuel if the ash were rejected in this condition.

The question as to the relative value of mechanical and hand-firing is still open, probably on account of the very indifferent results obtained from some machines, coupled with the disproportionately high repair bill. A stoker to be worth its place should be, as the name implies, capable of covering the grate evenly, and not, as some are, merely an apparatus for throwing coal on the bars in two or three promiscuous heaps to be distributed afterwards by the fireman's rake. The losses entailed by too frequent opening of the furnace doors, are shown very prominently on the CO_2 record, and the advantages of mechanical over hand-firing are in this respect very apparent, and establish the fact of the undoubted economy to be obtained by the use of a good stoker. The admission of cold air, with its consequent chilling of the furnace, formation of smoke and bad effects on the boiler itself, is a drawback which it is very desirable to avoid. With a hand-fired boiler, steaming hard, the doors will be opened every few minutes, a proceeding which cannot occur without involving loss of economy in steaming. That this loss is very considerable is shown on the illustration which is the CO_2 chart of a boiler fired alternately for periods of about two hours each, mechanically and by hand. The evaporation of the boiler was about the same in each case, but the difference in economy is distinctly marked in the altered proportion of CO_2 under the two conditions. The mean percentage of CO_2 as measured by the planimeter is in the former case 11 per cent. and in the latter 6.3 per cent. Referring to the table in a previous article (vol. i., No. 6, p. 649), this difference represents a loss of 13 per cent. of the coal when hand fired.

Up to this point the matters discussed have been those affecting efficiency in the transmission of the heat of the coal to the boiler plates, and it is now proposed to investigate its further transference to the water, and the extent to which this operation is modified by the internal condition of the boiler.

The presence of scale is usually regarded as very inimical to the attainment of high evaporative duty. This prevailing impression founded on the resistance of scale to the transmission of heat, is inaccurate when applied to the conditions under which boilers are worked. The error can be easily demon-

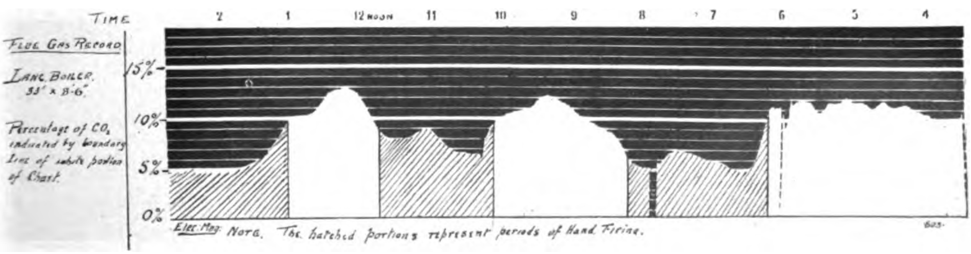


FIG. 1.

strated by considering the initial and final temperatures of the gases in their course through the flues. The difference between these two temperatures represents the heat given to the boiler and this figure will be found to be very slightly, if at all, modified whether scale is present or not, thus showing that the total absorption of heat from the gases is not greatly affected. The actual effect of scale is to reduce the rate at which the gases give up their heat by allowing the furnace plates to take a higher temperature than they would otherwise attain.

The temperature of a clean plate is only some 20° F. higher than that of the water in the boiler, and as the rate of transference of heat from one body to another is proportional to their difference of temperature, this comparatively cold plate abstracts heat very rapidly, and cools the flue gases correspondingly quickly. A plate covered with scale ⅛-inch thick may reach a temperature some 250° to 300° F. above that of the water, and consequently does not deprive the gases of their heat as fast as the colder plate. Eventually, however, the total amount of heat given to the boiler is nearly the same, and the work done by the boiler is not modified to any great extent.

It must not be presumed from this that scale is to be considered any the less undesirable because economy is not greatly at stake. The heating of the boiler plate is accompanied by severe strains which make themselves evident in grooving, leakages of seams and rivets, and consequent shortening of the life of the boiler. In a recent paper read before the Institute of Mechanical Engineers, the result of opening the fire-doors of a boiler with ⅛-inch of scale or a film of grease on the plates, was shown to be a contraction, due to cooling, of ⅙-inch in 8 ft., or equivalent to a strain of 22 tons. If the plates are free from scale and grease this contraction becomes very slight, and the main objection to the opening of the doors more than necessary, is simply that of loss of economy in firing.

The most usual scale found in boilers consists largely of calcium sulphate, and, in some cases, calcium carbonate. Calcium sulphate is much more soluble in cold than in hot water, and the best method of dealing with such a scale is to retain the water until cold in the boiler after letting down the steam. This has the effect of re-dissolving and disintegrating the scale and lifting it from the plates. Calcium carbonate scale is unlikely to occur in boilers where economisers are installed, as the slow flow of water and moderate heat in the latter are favourable to its deposition without reaching the boilers.

With regard to the treatment of scale, it should be unnecessary to warn engineers against the haphazard application of boiler fluids and compositions, some of which are undoubtedly good or at least harmless, while others are mere concoctions of soda salts, sold by men who know nothing whatever of the chemical constitution of scale, nor in many cases of their own boiler compositions.

The only rational method is to have the water examined by some competent analyst and to find the correct amounts of caustic soda, burnt lime, or soda ash to be added per 1000 gallons to effect the necessary precipitation. Whether this shall be done in the boilers or externally in a settling tank is a matter which must be decided on the merits of each case.

Grease on boiler-plates is much worse than scale in its results, and the merest trace has an effect in producing over-heating of plates and leakage of seams apparently quite incommensurate with the cause. This difficulty constitutes the greatest disadvantage of the use of the condensed steam for boiler feed, and unfortunately feed water filters are not very effective for the total removal of grease. The oil arrested by the filter is that which floats on the top of the water, but a certain amount becomes thoroughly emulsified with it, passing through any filter with comparative ease and being fed to the boilers. Here by the high temperature, it is thrown down on the plates in the form of a light film. It is not, as is popularly supposed, the excess oil on the top of the water which does harm, but the very slight amount intimately mixed with it, and this should be as far as possible prevented by the use of as little cylinder oil as is necessary, and by endeavouring to obtain an oil which does not emulsify with water to any great extent. Otherwise the only reliable method of freeing the water from all trace of grease is the use of water softening plant.

The regular cleaning of boilers is a matter of great importance, but it is impossible to specify a definite period of work, as this entirely depends on the class of coal, water, and other considerations. It is, however, advisable to err on the side of too frequent cleaning rather than the reverse. From results obtained with Lancashire boilers using mill slack and fairly good feed water, it has been found that eight weeks' run on an eight-hour day basis is about the most economical arrangement, giving an annual cleaning cost per boiler of about £8 to £9. In cases where good, clean coal is used, and where the purity of the feed water can be guaranteed, the running period can be indefinitely prolonged at the discretion of the engineer, and will be fixed by the length of time which it is considered safe to allow between successive external and internal examinations of the boiler and its settings.

(*To be continued.*)

Electrical artisans should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles on subjects of importance to themselves.

To make a 2-h.p. Motor or 25 Light Dynamo.

IN Fig. 1 a sectional elevation of the complete machine is shown. The field is of cast steel with poles cast in, integral pole pieces being bolted up to poles by a long $\frac{5}{8}$ in. bolt passed through the core from the outside and screwing into the pole-piece. Pole-pieces are cast together with thin webs, chucked in a four-jaw chuck and the out extensions turned to a light driving fit in the 9 in. bore of the poles cast with the field. The webs are then cut and $\frac{5}{8}$ in. holes drilled and tapped, corners rounded off to $\frac{1}{4}$ in. radius. The field, when machined, is strapped to the face plate, the core ends bored 9 in. diameter and the exposed edge of the yoke ring faced and recessed for the journal ring. The frame is then strapped to a special face plate filling the newly recessed ring, the whole carefully centred and the recess for the other journal cut. Fig. 3 is a section through the complete motor showing armature, field and bearings. Fig. 4 shows the journal bracket for the commutator end and this needs little or no explanation, while the pulley end ring can be gathered from Figs. 1 and 2. The hole for the shaft bushing will be best drilled first and the bracket mounted on a mandril bracing it from the inside by a CI disc $8\frac{1}{2}$ in. diameter. The bearing bushings are of hard brass or phosphor-bronze, and each should be bored out first, and then mounted on the mandril and finished on the outside. An oil groove should be tooled in each end and an oil ring slot $\frac{1}{4}$ in. wide cut, though this is preferably cored and cleaned up with a fine file. The oil ring is of $\frac{1}{16}$ in. stuff $2\frac{1}{4}$ in. inside diameter and $\frac{3}{8}$ in. wide. From Fig. 1 it will be seen that the bushes are not identical, that at the pulley end being stronger and longer than the commutator end. The shaft is preferably of low carbon tool steel, which if used should be rough turned to $\frac{1}{16}$ of final diameter, heated a dark red and allowed to cool, when it is turned required size. This process leaves the shaft straight without internal stresses, and it will always remain so.

The armature is slotted drum type with core discs mounted on a CI spider pinned to the shaft (Fig. 1). The core is built of No. 20 gauge discs of best electrical steel, stamped with 47 slots for the armature coils. If stampings cannot be procured, cut up sheet steel requisite gauge into squares $7\frac{1}{8}$ in. each way, punching out centre hole and clamping sheets between two CI or WI discs $6\frac{7}{8}$ in. diameter. Mount on a mandril, turn down to required diameter, starting tool in the flat face of the mass and not against the corners. Each hole should be punched with a keyway and the slots milled out after marking off. When complete the core should be washed in a hot solution of potash to clean out oil. Then varnish discs on each side and assemble discs on armature spider with $\frac{1}{16}$ in fibre disc at each end. The fibre should be first assembled with core for turning and slots cut simultaneously with discs. No. 6 standard taper pins are driven in to secure core to armature-shaft.

Armature slots to have micanite troughs $\frac{1}{64}$ in. thick for insulating, troughs being pressed in with a hardwood block shaped like the slot, but $\frac{1}{32}$ in. less in width. Armature coils are

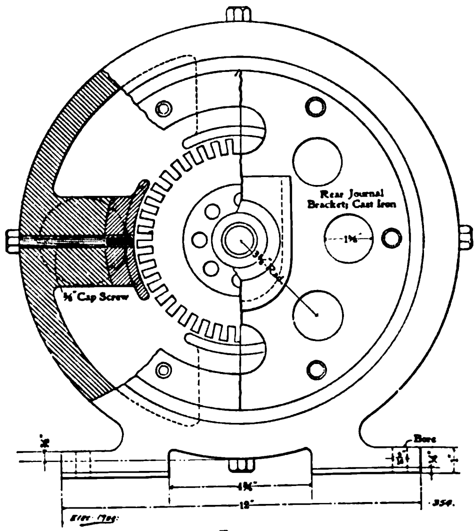


FIG. 1.

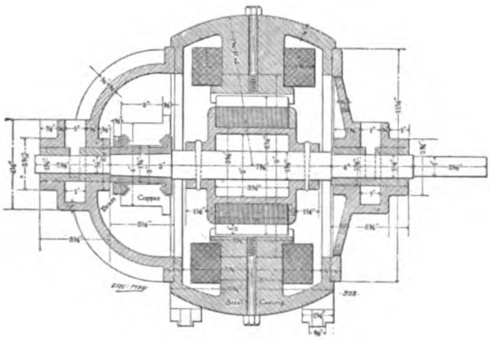


FIG. 2.

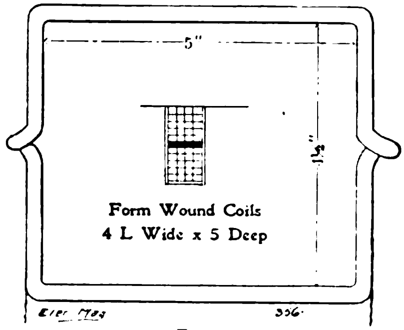


FIG. 4.

form wound as shown in Fig. 4. For 110 volts coils comprise 20 turns of No. 16 d.c.c. wire; for 230 volts, 40 turns of No. 19. Leave 8 in. on each coil end for connecting up, each tail being covered with a cotton sleeve extending not less than ½ in. into the coil. Shellac the coils well after wrapping with single layer of German linen tape, and assemble on the core before completely dry to facilitate handling. There are 47 coils, and each embraces 12 core teeth. The terminals are connected up "1 and 24," or to segments between which there are 22 segments. For the commutator, select from the catalogues of various segment makers a stock segment nearest the shape and size of that shown in Fig. 2. The shell and clamping collar are fitted to the size and shape of the selected segment. The micanite dividing strips should be 30 mm. thick. Assemble the segments in a drawing down ring ½ in. larger in diameter than the commutator barrel, and fitted with two rows of set screws pointing radial to the ring centre. Shellac each segment and strip before putting in place and tighten up each screw until the commutator is approximately cylindrical. Then bake hard and with clamping ring still in place, clamp the commutator complete between the bevelled plates on the shaft. The whole is now turned up, and the slots cut for the wires in the segment lugs. After testing commutator, put binding wires (No. 18 hard brass) on the armature, over a layer of pure mica, three sets, in middle and ends being laid on. Field coils to be wound on mica or fibre spools, each having same number of turns of wire. For 110 volts use No. 23 wire, and 230

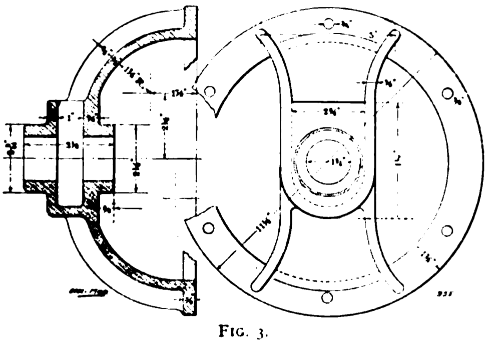


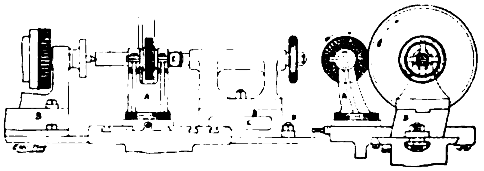
FIG. 3.

volts No. 27 wire, built up to the dimensions in Fig. 1. Careful winding will ensure from 3000 to 3100 turns, No. 23, per coil. Inner ends should be connected to outers for adjacent coils. The brush holders are quite simple and need no explanation; the brushes to be of carbon.

As a motor the machine will run on 950 r.p.m. and as a dynamo 1000 to 1025 r.p.m. A starting box or field rheostat as the case may be are best purchased of some standard manufacturers. The above data and illustrations are abstracted from the *American Electrician*.

GRINDING CHILLED CAR WHEELS.

THE fixture here shown was designed for grinding chilled wheels for tramcars, electric cranes, &c., in the ordinary lathe, and works well, where the quantity done is not sufficient to warrant the



FIXTURE FOR GRINDING CHILLED CAR WHEELS.

expense of a special grinding machine. The main casting, or ribbed bracket A has a base turned to fit on the swivel of the slide rest, and takes the place of the top slide which is removed; the top terminates in two bearings carrying the emery wheel spindle. The bearings are brass-bushed, shown in dotted lines in the end elevation, and held in position by a stop peg on top. These bushes have a saw groove cut the full length to allow for adjustment for wear, by the two sets-screws ⅝ in. diameter shown on the lugs cast on front of bearings. These lugs have also a groove shaped across the point after they are bored out, and a thin strip of fibre packing inserted, for the sets-screws to pull tight down on to. The small double-flanged driving pulley E is held on the spindle by a ½-in. grub screw, the emery wheel is held in position by thin circular washers and locknuts, and is driven in the direction indicated by the arrows from a small overhead countershaft, the work in the lathe being driven backwards. Blocks B are used to raise the centres the requisite height to allow of sufficient swing. C is a handhole to admit a spanner. D is a supplementary bolt which gives additional security when heavy weights are swung in the centres.—W.D.

ELECTRICAL TRADE and COMMERCE

Trade and Commerce Articles of the month are classified under the World's Electrical Literature Section at end of Magazine.

(Through pressure on our space this Section is curtailed this month.)

Looking Abroad.

By W. N. TWELVETREES, M.I.Mech.E., A.M.I.E.E.

At a time like the present when great activity is evidenced in the development of lighting, power and traction schemes at home, the natural tendency is for those concerned in electrical trade and commerce to be satisfied with the opportunities thus presented, and to relax their efforts to secure business in other countries. Owing to the unparalleled activity of our foreign competitors and the deterrent effect of hostile tariffs, various markets are practically closed to British exporters, but in many parts of the world there is ample scope for enterprise. We have already pointed out the excellent openings for trade in South American states, and in the present issue references will be found to further schemes which involve large purchases of plant and equipment. In Mexico, the installation of electric tramways and the establishment of power-plants are noteworthy features. Schemes for steam- and water-power plants are also under consideration in Venezuela, Nicaragua, and other states, and unless vigorous action be taken, orders for the necessary equipment will inevitably gravitate to the United States. Turning to the Far East we find electric railway and tramway schemes are projected or in the course of realisation in China and Japan, and that American manufacturers have already given evidence of their alertness by securing some important orders for steam turbines, generators, and electric motors. In Egypt, again, there is much scope for British energy. Electric lighting is the order of the day in the land of the Pharoahs, an extensive hydraulic power installation is now contemplated in the fertile province of the Fayoum, and electricity is being applied more and more every year for pumping water and for the driving of machinery in mills and factories. We could cite many other instances of the opportunities now awaiting attention but it is scarcely necessary to do so, as those already mentioned are sufficient to emphasise the moral of these remarks. One most important point, however, is that success in securing foreign trade depends very largely upon compliance with local methods of business. Catalogues should invariably be printed in the language of the country, quotations must be based upon accepted units of money, weights, and measures, and in every case prices should include free delivery. There is nothing so inimical to the progress of trade abroad than the conservative method of adhering to the British language and nomenclature, a fatal error which is religiously avoided by our foreign competitors.

GENERAL TRADE NOTES.

German and British Telegraph Companies' Rivalry in the East.

In spite of the opposition offered by the Eastern Telegraph Company a permit has at last been signed by the Porte, authorising the construction of the Constanza-Constantinople submarine cable by the East European Telegraph Company of Berlin. This Company was formed in the year 1899, for laying a cable connecting the Roumanian port of Constanza with the Turkish capital. In connection with this company an understanding between the German and Roumanian governments provided for direct telegraphic communication between Berlin and Bucharest, with an extension to Constanza and Constantinople and it was then agreed that Roumania should pay an annual subsidy of £2000, and should not grant any other concession for the laying of a cable between that country and Turkey. No objection was made to the laying of the land-line, but the Eastern Telegraph Company, claiming the exclusive right of laying cables in Turkey opposed the concession for the cable in the Black Sea, which it was stated would also be the cause of much competition to the Eastern Telegraph Cable between Constantinople and Odessa. The new German cable, the laying of which has not been commenced, will constitute part of a system extending from Berlin to the Persian Gulf, and will also compete with the line of the Indo-

European Telegraph Company, whose cable passes through Odessa, Kersh, Tiflis, and Teheran, and extends to the Persian Gulf.

A New Dutch Cable Company.

We learn from the *Frankfurter Zeitung*, that it is proposed to establish a telegraph cable between Menado, a Dutch Indian island, and Guam and Shanghai. It seems that the object of this cable is to form, together with the American cable, a means of communication with the Far East, which will in no way be dependent upon England. The proposed company will have a share capital of £350,000 and a 4 per cent. bond issue amounting to £362,500, and it appears that considerable grants are likely to be given to the company by both Germany and Holland. The Disconto Gesellschaft, the Darmstadt Bank, the Dresden Bank, the Schaaffhausen Bank, Verein, the Amsterdam Bank, and the Netherlands Handels Maatschappy, are some of the commercial corporations associated with this scheme.

Trade in Mexico.

A contract for the construction and equipment of a water-power plant of 1000-h.p. capacity has recently been secured by Messrs. Ugarte and Garcia, of Guadalajara, Mexico. The equipment which is to be manufactured in the United States, includes the supply of three 250 kw. alternating-current generators to be direct-connected to water-turbines. It is estimated that the length of the transmission line will be about fifteen miles, and that the whole plant will probably be in operation within a year. It is interesting to note that the introduction of electric traction to Guadalajara has caused an immense difference in the number of passengers carried, as is evidenced by the fact that the total number carried during the last year in which mule-cars were run was seventeen millions, and after the introduction of electric cars thirty-three millions. Another important electrical contract in Mexico is the installation, by the Compania Minera de Penoles, of a large storage battery outfit for the smelter plant in the mines in the State of Durango. It is now being proposed to construct an additional electric tramline in the town and suburbs of Guadalajara, and the Electric Sociedad Anonyma, which has control over the franchise for electric lighting and tramways in that town, is about to make arrangements for the supply of the machinery required, at an estimated cost of £200,000. Many well-known mining companies in the Guanajuata district are now about to be reorganised, and for this purpose a new company has been inaugurated with a total capital of £1,400,100. Under the management of this company the most up-to-date electrical machinery and apparatus will be applied. In place of the two-mile mule-tramway in Mazatalan, an electric track system is shortly to be constructed, and contracts for the equipment of these lines, which will extend for a distance of about five miles, will most probably be placed in the United States.

CONTRACTS CLOSED.

Power.

Bristol Corporation: 400 kw. generator; Bruce, Peebles & Co.

Birkenhead Corporation: Extensions to feeder and distributing mains; Johnson & Phillips.

Londonderry: Battery; Hart Accumulator Co.

Chatham Dockyard (through Bruce, Peebles & Co.): Six sets of surface condensing plant; Isaac Storey & Sons.

Dublin Corporation: 1500 kw. three-phase steam generating plant, &c., £19,227; General Electric Co. Ltd.

Hollymoore Asylum: Motor equipment for asylum laundry; Brush Electrical Engineering Co. Ltd.

Poplar Borough Council: Storage battery, £1860; Electrical Power Storage Co. Ltd.

West Hartlepool: Twenty-eight motors ranging from 8 to 62 h.p.; Brush Electrical Eng. Co. Ltd.

Glasgow Electricity Department of Corporation: Low-tension switchboards and instruments, £604; Witting, Eborall & Co. Ltd.; British Westinghouse Electrical & Manufacturing Co., £752.

Mexborough: Two 100-kw. direct driven steam sets; Mavor & Coulson.

Aliwal North Town Council (South Africa): Storage battery of 256 central-station type cells: Hart Accumulator Co. Ltd.

Lighting and Heating.

Islington: Seventy-eight electric arc-lamps; Crompton & Co.

Bridgewater: Storage battery for electric lighting; Hart Accumulator Co.

Metropolitan Asylums Board: Electric lighting at Western Hospital & Ambulance Station, £3270; Donnison, Sillem & Co.

Aberdeen Electric Lighting Committee: Surface Condensing Plant, air-pump, and piping; Blake & Knowles Steam Pump Co.

Loughborough Corporation: 260 cell storage battery for electric lighting; Pritchetts & Gold, Ltd.

Stafford Town Council: Electric light cables; Callender's Cable & Construction Co., Ltd.

Torquay: Equipment for electric lighting of the Imperial Hotel; T. L. Harding & Co.

Canterbury City Council: Cable and additional feeders, £902; Western Electric Co.

Bury Joint Hospital Board: Electric light in the new diphtheria pavilion; Mr. Joseph Downham.

Middlesex County Council: Electric light wiring and fittings for the new asylum at Napsbury, £5343; Wells, Rayner & Co.

Acton Urban District Council: Supply of Dialite insulated cables, £31,536; St. Helens Cable Co.

Traction and Transport.

Poplar Borough Council: Eight miles of cables, £2496; Western Electric Co., Ltd.

Kilmarnock Town Council: Permanent way construction in connection with electric tramway system, £22,784; Dick, Kerr & Co.

Stalybridge, Hyde, Mossley & Dukinfield Tramways & Electricity Board: Equipment of overhead wires in the main car-shed; Dick, Kerr & Co.

HOME TRADE NOTES.

Messrs. Mather & Platt, Ltd.—The Crown Agents for the Colonies have just placed an order for a small alternator for Lagos. This machine will be direct-coupled to a Belliss engine running at 480 r.p.m. and will give an output of 60 kw. at 1000 volts, 80 cycles, and will have a direct-coupled exciter.

Messrs. James Howden & Co.—One 550-650-kw. engine, Hanley Corporation (through the British Westinghouse Co.); one 220-k.w. engine, Lincoln Corporation (through Bruce, Peebles & Co.); one 290-b.h.p. engine, Bruce, Peebles & Co., Ltd.; two 80-b.h.p. engines, Lanark County Council (through Johnston Park & Co.); one 40-b.h.p. engine, Glasgow Corporation (through Wm. Harvie & Co.).

Matthews & Yates, Ltd.—We are pleased to announce that this firm have just recently supplied Messrs. Donat & Co., of Manchester, with the 9-ft. fans for the Preston Corporation Towers, and also the Klein Engineering Co. Ltd., with similar fans for Calcutta. The same firm have, we understand, just been favoured with a large order from the Brush Electrical Engineering Co. Ltd., Loughborough, for a Cyclone Collecting plant in connection with their car-building sheds.

Admiralty Contract.—Messrs. Graham, Morton & Co. have just completed an important contract for the Admiralty for coal-handling plant in connection with the Royal Dockyard Electricity Supply. This includes the supply, delivery, and erection of coal-bunkers, stanchions, girders, flue-uptakes, coaling cranes, and coal-weighing apparatus. The work includes seven one-ton electric cranes fixed on the boiler-house roof, and an ash hoisting electric gib on the boiler-house wall. The coal-conveying plant is of Graham Morton's well-known design, widely used in electricity works.

ELECTRIC FINANCE

and Legislation

Running Powers.

By the ASSOCIATE EDITOR.

In every large town the problem of providing adequate facilities for locomotion so as to enable the workers to quit the scenes of their labour in the evenings and live in the open country, is a very pressing one and a very difficult one, and by a large section of the community the electric tramway has been welcomed as affording at last a solution. There can be little doubt that this view is to a very large extent justified and that the electric tramways now laid down are conferring a great boon on millions of people ; but when we study more closely the actual position of affairs, we find that the number of cases in which tramcars do run from the heart of the labouring districts of towns right out into the open country is comparatively small. We have, indeed, many country tramways and many town tramways, but in too many cases the link between these is wanting. The reason of this is fairly obvious. Parliament in its wisdom has given to local authorities the power to become each the tramway authority in its own area, and these areas have boundaries, which however suitable they may be for civic purposes, are quite absurd for tramway purposes. Practically all the large and important municipalities in the country are now running their own tramways and have excellent systems within their own areas, but the surrounding territory is in the hands of others—local authorities or companies—and the journey from the centre of the town to the open country can only be made by a change from the car of one system to that of the other when the geographical boundary is crossed.

It is clear that such a state of affairs is inimical to the interests of the public as it prevents full advantage being taken of the benefits derivable from the electric tramway, and it becomes a matter of great importance to find a means of getting rid of these artificial restrictions. To change the law radically would be the best way out of the difficulty, but he would be a bold man who would prophesy that there is any prospect of this being done. Nor is it more reasonable to suggest that the municipal authorities, while remaining owners of their lines, should lease them to companies and leave them to run the cars. That would be the most natural solution and one that would be easy to introduce ; but no one expects the local authorities concerned to take this view at the present time when the desire for municipal trading is so strong. Later on, we may find this view more common, but for the present trouble we want an immediate remedy. There only remains one other course. Arrangements must be made between the owners of neighbouring systems to allow each to run its cars—or some of them—over the lines of the other and thus provide through-cars from town to country.

How is this to be done ? Obviously, the most natural way is by private agreement, but there again the foolish antipathy which local authorities manifest against any proposal to allow a car belonging to a private company on their lines, is at once a bar to negotiations. It might be capable of the most clear proof that a through route across the municipal boundary was a crying necessity ; yet would the municipal corporation reject at once any proposal to establish such a route unless on the understanding that the municipal cars should be at liberty to go on to the neighbouring system but that the company's cars should not cross the municipal boundary. Of course a one-sided agreement of this kind is not worthy of consideration and is somewhat disgraceful to those who propose it, but unfortunately it is not hypothetical. If, then, through-routes cannot be arranged by private agreement, the only means of obtaining them is by Act of Parliament, which overrules any private objections either party may have in order to advance the public interest. Various attempts have been made to induce Parliament in previous sessions to grant such running powers as we are now considering, but these have met with no success as the

influence of the local authorities has proved too strong. At last, however, a change has taken place, for in the present session a bill promoted by a company asking for running powers over municipal lines has been passed by Committees of both Houses. It has to be admitted that on the report stage in the House of Commons there was an adverse vote on this point, and the Bill has been sent back to Committee, but the very fact that such a Bill has passed Committees of both Houses marks a great step of progress and promises well for the future. The case is one of great interest and may with advantage be considered at some length.

The bill in question was promoted by the Tyneside Tramways Company, whose lines run up to the boundary of Newcastle-on-Tyne, while the Corporation tramway lines begin there and run through the city. The company asked powers to run its cars across the boundary and into the heart of Newcastle, at the same time granting similar powers to the corporation to run their cars over the company's lines to Wallsend. It was admitted that the principal traffic is from Wallsend to Newcastle and that it is a decided disadvantage that the public should be required to change cars at the boundary. Before the Bill was brought forward an attempt had been made by the company to make an arrangement with the Corporation by private agreement for reciprocal running-powers, and at first the Newcastle Tramways Committee was in favour of this being done. But subsequently the Corporation rejected the proposal and refused to consider the question further; so nothing remained for the Company but to come to Parliament. The Bill was first dealt with by a House of Lords Committee, and it must be said that both here and subsequently before the Committee of the House of Commons the Newcastle Corporation made a very pitiful show.

The case for the Corporation was that if running powers were to be introduced at all, it must be, or ought to be, by private agreement, but that to enforce such a thing by Act of Parliament would be wholly wrong. Their representatives had to admit that in this case a system of through-cars would be a great public gain, and that for that reason alone it was most desirable that an arrangement should be made for cars to run over both systems. It had also to be admitted that the company was willing to come to such an arrangement but that the Corporation had declined to do so; and the advocates for the Corporation were placed in the ridiculous position of contending that through-cars, which would admittedly be excellent and advantageous if labelled "Private Agreement," would become at once objectionable and disadvantageous if the label were changed to "Compulsory Powers."

Of course the old argument that there was no precedent for granting such powers was used for all it was worth, but the case for the company was put forward boldly on the ground that the existence of a precedent was immaterial, for the circumstances were such as could only be met by the grant of the reciprocal powers asked for in the Bill. This view was accepted by the House of Lords Committee and the Bill passed through all the stages in that House and was sent to the House of Commons. There the same fight has had to be gone through again, for the Newcastle Corporaation backed by all the local authorities owning tramways, has made a desperate effort to get the Bill thrown out. In the Upper House the position of the Corporation was, as we have seen, sufficiently ridiculous, but before the Commons Committee it became more so, as a proposal was there actually put forward by the Corporation that they should meet the public demand by running their cars over the company's lines, but that none of the company's cars should be admitted to Newcastle! It is really difficult to understand how anybody could have the effrontery—for it is nothing else—to put forward such a proposal after all that had taken place before the two Committees. Naturally it was not accepted; indeed, it only recoiled on the heads of those responsible for it, as it enabled counsel for the company to expose the real aim of the Corporation as a desire to capture the lines of the company, and to do by stealth or strategy what Parliament had declared they should not do, at the time the powers for these lines were granted. The Committee granted compulsory running powers by a unanimous vote.

This contest is of great importance. It has shown us that Parliamentary Committees are no longer willing to be unduly influenced by the local authorities but are prepared to overrule these bodies in the public interest. It is no doubt remarkable that local authorities, elected by popular vote to attend to the public interest, should run counter to it; but that they frequently do so is abundantly proved, and never more so than in the present case. The truth is that in tramway matters local authorities are apt to act not as representatives of the people but simply as a commercial trading body, and to use for the purposes of that trade the power and influence which were given them as representatives. If proof were wanted, one need only point to the organised efforts made to secure the reversal of the decision of the Committees in this Newcastle case and to the private conclaves at Westminster of representatives of municipal corporations

owning tramways. It would be interesting to inquire what interest towns like Glasgow, Liverpool, and Manchester have in the tramway system of Newcastle-upon-Tyne, or why they should be so much concerned at the mere fact that Parliamentary Committees, on the plainest of evidence, have decreed that the Tyneside Company and the Corporation shall have reciprocal running powers over certain parts of the two systems. The fact that these local authotities do take such an active interest in matters with which they have no concern, and join in the agitation to induce the House of Commons to overrule the decision of its Committee, is a clear proof that whatever be the merits of any case for running powers, the local authorities, acting together as a sort of trade union, are prepared to resist any proposal which would allow a car not owned by the Corporation to cross inside the municipal boundary. It is well to recognise this position clearly. We confidently expect that ere long Parliament will show that it cannot be maintained.

ELECTRIC LIGHTING NOTES.

An Amalgamation.

In the 1903 session of Parliament an Act was passed enabling the Blackheath and Greenwich District Electric Light Company, Ltd., to purchase by agreement the undertaking of the Crystal Palace Electric Supply Company, Ltd., and since the passing of this Act arrangements have been in progress for the actual transfer. These were completed a few weeks ago, and henceforth the number of lighting authorities in the County of London will be reduced by one. This union should improve very considerably the prospects of the Blackheath and Greenwich Company. It has now control of a very extensive area, and an area capable of great development. The old area itself gave the company a good power load, but this should now be considerably increased as generation on a much larger scale will reduce the working expenditure per unit produced, so that cheap power will be available for manufacturers, and will, no doubt, be much in demand. The prospects for the ordinary lighting load are also good, as the population of this area is increasing rapidly, and altogether we hope to see good financial returns in future issued by this company. The system of supply by the Crystal Palace Company is by direct current, but this will now be changed to alternating current to be uniform with that used by the Blackheath and Greenwich Company in its old area.

Supply in Bulk to a Local Authority.

We congratulate the Stourbridge Council on its decision not to generate electricity for its own area, but to take its supply in bulk from the Midland Electric Corporation. Under modern conditions there must be a great loss of economy if every local authority insists on having its own complete system of generation and supply for its small area, while having at its doors a company generating on a large scale. In such cases the building of a generating station is a needless waste of capital, producing nothing but an increase in the local debt. In Stourbridge there has been a keen fight over this matter, and the decision now arrived at is very largely due to the inspector who superintended a recent local inquiry, and who threw out the suggestion which has now been acted upon. The Council will have complete control of the distribution in its area, but will take the current in bulk from the company; and by this arrangement both the corporation and the company will profit. We are glad to think that this common-sense view of the economics of electric lighting is spreading among local authorities.

Brighton Electricity Department.

The Brighton electric lighting accounts for the year ending March 31, 1904, were presented at a meeting of the Corporation a few weeks ago, and we regret to say that they do not appear to us to show a very satisfactory state of affairs. It is true the receipts are considerably larger than those for the previous year, and the gross profit is £38,335 9*s.* 9*d.* as compared with £35,184 5*s.* 11*d.* for 1902–1903; but when we examine the net revenue account we see clearly that the financial position of the undertaking is not what it should be. Of the gross profit, no less than £31,376 5*s.* 6*d.* is swallowed up by interest on loans and repayment of loans, leaving only a net profit of £6959 4*s.* 3*d.*, which is all carried to reserve fund. Thus there is absolutely no provision for depreciation in any form, in spite of the very large capital expenditure and the reserve fund before receiving this addition of nearly £7000 only stood at £8530 11*s.* It must further be remembered that Brighton is increasing its debt by treating as capital expenditure what ought to come out of revenue, for it is now trying to borrow a fresh loan to meet the cost of changing the voltage of supply—a change which does not create a new asset to represent the money spent on it. If this system of finance is continued, we feel quite certain that there is an evil day ahead for the ratepayers of Brighton, as by-and-by they will be called upon to replace worn-out machinery and plant which will still stand in the books at its full original value; the reserve fund will be hopelessly inadequate; and, far from being in possession of a "going concern" free of debt, they will have to incur fresh loans before the original loan is paid off, and will be compelled to go on paying interest on that original loan, although there are no longer any assets to represent it. The usual answer to criticisms regarding the want of depreciation allowances is that there are different views as to depreciation and although this is not an answer, it is unfortunately too true. But there is only one correct view, and that the Brighton view is not correct we have absolutely no doubt. We hope the ratepayers of Brighton will force this matter on the attention of their representatives.

The leading contents of the periodical electrical press of the world, papers read before Learned Societies, and any other literature treating upon electrical subjects are arranged *under subject-matter* in this section. Suitable references are made to the names and dates of the various papers, and the whole forms an index guide of considerable importance and value.

Power.

Articles.

•Producer Gas and its Power Application. H. Allen.	*Power, June/04.*
Power Pumps. W. E. Crane.	*Power, June/04.*
•Direct-Current Systems of Electric Drive.	*Elec. Club Jrnl. June/04.*
Use of Electric Power in Hamilton.	*Canad. Elec. News, June/04.*
Electricity on the Lachine Canal. L. A. Herdt.	*Canad. Elec. News, June/04.*
Experiences with H. T. Transmission Lines. H. C. Reagan.	*Strt. Rly. Rev. June/04.*
Installation for the New Minnesota State Capital.	*Westrn. Electn.* 4/6/04.
Electric Installations on Board Warships. (Serial.) Leblond.	*L'Ind. Elec.* 10/6/04, 25/6/04.
•Hudson River Power in the G. E. Co.'s Works.	*Elec. Wrld. & Engr.* 11/6/04.
Chevres Hydro-Electric Plant. A. de Courcey.	*Westrn. Elect.* 11/6/04.
•Snoqualmie Falls and White River Power Plant. F. C. Perkins.	*Elec. Rev. N.Y.* 18/6/04.
•Bear River Power Plant and Utah Transmission Systems. (I.) (Concld. 25/6/04)	*Elec. Wrld. & Engr.* 18/6/04.
Power Plants of New Orleans Railway Co.	*Strt. Rly. Jrnl.* 18/6/04.
•Influence of the Line on the Parallel Operation of Synchronous Motors.	*Elec. Wrld. & Engr.* 18/6/04.
•Variation of Motor Speed with Variable Line Voltage. J. L. Dickson.	*Elec. Wrld. & Engr.* 18/6/04.
Electrical Plant at Heysham Harbour.	*Electn.* 24/6/04.
•Electrical Equipment of a Modern Type Foundry.	*Elec. Rev. N.Y.* 25/6/04.
Notes on the Steam Turbine. H. F. Schmidt.	*Strt. Rly. Jrnl.* 25/6/04.
Protection of Electric Plants from Atmospheric Discharges. (Serial.) Montpellier.	*L'Electn.* 11/6/04, 25/6/04.
Hydro-Electric Installation of the "Alta-Italia" Co. Dary.	*L'Electn.* 25/6/04.
Electric Plant of the Western Railway Co. of France. Soubrier.	*Rev. Tec.* 25/5/04.
The Application of Polyphase Asynchronous Motors in Mines. Boucherot System. Brunswick.	*L'Electn.* 25/6/04, 2/7/04.

Papers before Societies.

Discussion on Hypertensions in Electric Mains. (Serial.)	*Bull, Sté. Int. des Electns. June/04.*
The Economical Problem of Transmissions of Energy.	*Bull, Sté. Int. des Electns. June/04.*
Hydro-Electric Plant at Hauterive (Switzerland). Dalemont.	*Montefio Inst.* 31/5/04.
Pressure Regulator for Alternators. Dupuy.	*L'Eclair. Elec.* 11/6/04.
Aluminium Wire as a Conductor. R. J. Parke.	*Canad. Elec. Assoc.* 15/6/04.
The Curtis Steam Turbine. F. C. Smallpiece.	*Canad. Elec. Assoc.* 15/6/04.
•Niagara Power Development. K. L. Aitken.	*Canad. Elec. Assoc.* 15/6/04.
•Statistics of Canadian Progress in Electrical Applications. G. Johnson.	*Canad. Elec. Assoc.* 16/6/04.
•Synchronous Motors for the Regulation of Power Factor and Line Voltage. B. G. Lamme.	*Amer. Inst. E. E.* 21/6/04.
•Protection of H. T. Lines Against Static Disturbances. H. C. Wirt.	*Amer. Inst. E.E.* 21/6/04.
•Line Construction with Steel Supporting-Structures and Long-Spans. F. O. Blackwell.	*Amer. Inst. E. E.* 21/6/04.

Traction and Transport.

Articles.

The Cintra and Praia das Macas Tramway Line. L. O.	*Electro. May/04.*
The Brussels-Antwerp Electric Railway. Lambotte.	*Electro. May/04.*
Boring Armature Bearings. S. P. Baird.	*Strt. Rly. Rev. June/04.*
•Railway Electrification. Philip Dawson.	*Lt. Rly. & Try. Jrl. June/04.*
•Railways and Electrification. J. W. Jacomb-Hood.	*Lt. Rly. & Try. Jrl. June/04.*
Is Electric Traction the Remedy? The Mersey Railway Evidence. Scrutator.	*Lt. Rly. & Try. Jrl. June/04.*
•The Single-Phase Commutator Motor as a Factor in the Railway Electrification Problem. H. M. Hobart.	*Lt. Rly. & Try. Jrl. June/04.*
The Municipal Tramways of Vienna.	*Lt. Rly. & Try. Jrl. June/04.*
Some Traffic Difficulties. W. J. McCombe.	*Lt. Rly. & Try. Jrl. June/04.*
Bury Corporation Tramways.	*Lt. Rly. & Try. Jrl. June/04.*
Growth of an Electric Railway. L. E. Gould.	*Strt. Rly. Rev. June/04.*
Narrow-Gauge Road from Lausanne to Mondon. E. Guarini.	*Strt. Rly. Rev. June/04.*
Emergency Car Stop for Bottom of a Dangerous Hill.	*Str. Rly. Jrnl.* 4/6/04.
First Electric Railway in Peru.	*Str. Rly. Jrnl.* 4/6/04.
•Selective Signalling on the Boston and Worcester Electric Railway.	*Str. Rly. Jrnl.* 4/6/04.
Re-Examination of Strt. Rly. Employees for Defective Senses. R. R. Rideout.	*Strt. Rly. Jrnl.* 4/6/04.
•Recent Elevated Practice in Berlin. J. P. Fox.	*Strt. Rly. Jrnl.* 4/6/04.
•Virginia Passenger and Power Cos. Y.M.C.A. S. W. Huff.	*Strt. Rly. Jrnl.* 4/6/04.
Speed Regulation of Electric Traction Motors. B. G. Lamme.	*Lt. Rly. & Try. Jrnl.* 10/6/04.
Street Railway Exhibits at the World's Fair	*Strt. Rly. Jrnl.* 11/6/04
•An Improved Terminal for the Heavy Coney Island Crowds. Brooklyn Rapid Transit Co.	*Strt. Rly. Jrnl.* 11/6/04.
•Elevated Car for Fire Fighting.	*Strt. Rly. Jrnl.* 11/6/04.
•Underground Construction. (II.) W. P. Hancock.	*Westrn. Elect.* 11/6/04.
Electro-Pneumatic Traction. (Sahulka System.) Dary.	*L'Electn.* 11/6/04.
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*Economiser Calculations. W. H. Booth.	*Power, June/04.*
*Entropy Diagram and its Uses. H. B. Brydon.	*Power, June/04.*
Indicating the Gas Engine. C. E. Sargent.	*Power, June/04.*
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*Protection of Cables from Arcs due to Failure of Adjacent Cables. W. G. Carlton.	*Amer. Inst. E. E.* 21/6/04.
*The Use of Ground Shields in Transformers. J. S. Peck.	*Amer. Inst. E. E.* 21/6/04.
*Organisation and Management of a Central Station Motor Department. A. J. Cridge.	*I.M.E.A.* 29/6/04.
*Polyphase Substations, their Equipment and Working. S. L. Pearce.	*I.M.E.A.*, 30/6/04.
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*Boiler House Economics. R. S. Downe.	*I.M.E.A.* 1/7/04.

Finance and Legislation.

*Financial Position of Municipal Electric Undertakings. J. R. Blakeway.	*I.M.E.A.*. 1/7/04.

Articles marked with an asterisk are of exceptional interest, and well worth reading. Copies of any article or paper can be obtained on application to this office, a nominal fee only being charged for the clerical time occupied in taking out same. If desired, the whole publication will be procured (same not being out of print) on payment of the published price.

Where foreign papers have a similar title to those published in this country, the initial letters of the place of publication will be inserted after the abbreviated name of the particular paper; for instance, the English Electrical Review will be abbreviated Elec. Rev., and the American Electrical Review, Elec. Rev. N.Y.

Forthcoming Events

Exhibitions.

Third International Congress of Mathematicians Heidelberg.
August 8 to 13, 1904.

Exposition Internationale au Grand Palais, Paris.
August to November 1904.

Industrial Exhibition, Cape Town.
November 1904 *to January* 1905.

The Tramways and Light Railways Exhibition, 1905, Agricultural Hall.
July 3, 1905.

Papers before Societies.

St. Louis International Association of Municipal Electricians.
September 13 *and* 14, 1904.

"Street Lighting: Principles Involved and Systems Used." A. S. Hatch.

"The Limitations of the Telephone for Fire Alarm Purposes." A. Bosch.

"The Inspection of Theatres from an Electrical Standpoint." W. H. Thompson.

"Methods of Testing." W. M. Petty.

(Patents, Reviews and Catalogues, are unavoidably held over this month.)

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INDUSTRIAL REDISTRIBUTION.

EVER since the problem of affording adequate breathing space and wholesome surroundings to the working classes — chiefly the artisans — and especially those congested portions represented by our large cities and towns, has been before civilised communities, various schemes for the solution of this difficult problem have been brought forward. Early in 1902 Mr. W. L. Madgen, in a noteworthy paper, read in February that year before the Society of Arts, entered a plea for improved electric railway and tramway facilities as a means of encouraging suburban traffic, and an aid to coping successfully with the increase in passengers so caused. Since that time — taking London as a typical instance—the network of suburban tramway systems has been vastly extended, and the mileage of radiating tube lines materially lengthened. In addition, the keen competition which steam lines have encountered from the two above-mentioned sources, has resulted in the acceleration of notoriously bad services as well as of those above the average. When the District and Metropolitan are running their electric service and the London Tubes are all operating, traffic facilities will present such changed conditions as would prompt the belief that further improvement was impossible. Especially might this feeling arise if the main steam suburban lines were electrically operated and a service given which admitted of intelligent co-operation with the tubes and trams within and without the congested districts. Judging from developments there is every reason to anticipate the harmonious working of a number of systems under the latest electrified conditions. The position arrived at may be said to represent the case for industrial redistribution as affected by increased traffic facilities, such facilities being only afforded by the electric train or tram. We are now speaking of what will transpire when London's suburban lines are electrified and a comprehensive system of tubes and trams is in operation.

The aspect of the case is here viewed from the point of carrying the workers to and from the city, which is the chief centre of their labour. Cheap transit would entice them to the suburbs, where they would enjoy the advantages of fresh air and clean surroundings. To provide this cheap transit (for London) some thousands of horse-power in power stations would be needed. These stations would require to be designed for the morning and evening traffic, which is much more exacting than the regular traffic between those times. Seeing that the service to the outskirts would be more attractive, and assuming that the great majority of the workers would avail themselves of it, the lines upon which present railway power houses are designed would afford no precedent

of the "peak" loads occasioned by such an influx of passengers morning and evening. We shall not over-estimate the case in saying that a very considerable standby plant would be needed, entailing heavy capital expenditure. Judging from the present congested state of some London lines at these times under the existing steam conditions, unfavourable to travel as they are, there is nothing to guide us in forming an opinion of the capacity of a similar line when electrified and doubly attractive to passengers. Overcrowding is not unknown on certain tube lines now, despite the possibilities of accelerated service. While admitting, then, that an improved electric service of trains, tubes, and trams may apparently solve the problem, experience affords little or nothing which will indicate if these means will prove equal to the task of moving twice daily practically the whole working population of a huge city. We have daily evidence of their ability to cope with a regular flow of passengers and a certain class of "peak," but not of that rush which might be anticipated if the general body of workers were dealt with.

In considering the power required to operate such an electric transit service, the mind naturally turns to the reason for this diurnal moving of the working populace. Why must the workers be tempted into the outskirts by improved transit methods? Because they live in congested districts and the atmosphere in towns is polluted with the smoke of houses and steam-driven factories. At once the thought arises that the atmosphere might be cleared of much of its soot by the employment of electric power in place of steam. The power houses now being installed to furnish power for electric railways, with the object of daily running the workers from their polluted surroundings, could be equally well employed in distributing that power to the very factories they assist the people in fleeing from. For a city the size of London the possibilities of such a step are naturally very remote, though its results would materially enhance the industrial conditions of the working classes.

From the evidence afforded by electric traction, both heavy and light, in the past, and likely to be contributed by them in the next decade, the problem of industrial distribution is unlikely to meet with solution by their aid. The proceeding of moving twice daily masses of people from the country to the town, and *vice versa*, is but a temporary expedient. It does not strike at the root of the evil. It may in fact be said to pander to it.

There are strong indications, in our opinion, of a satisfactory solution of the difficulty from a source only hinted at in the above remarks. We allude to the growth of the great power schemes in the country and the influence it is likely to have on the conduct of manufacture. Looking abroad, there is an unmistakable tendency toward decentralisation of labour in certain trades in which electric power has been employed to drive machinery. At one time the congregation of men and women into large factories was deemed expedient on grounds of economy in operation, a measure directly resulting from the necessity for concentrating the power required to operate the machinery. With electricity, however, concentration is not necessary, and power can be better distributed to small isolated shops engaging a limited number of hands. In France, Switzerland, and Northern Italy many important domestic industries are being revived by the use of hydro-electric power, while the industrial atmosphere created around the workers is ideal in character. In a few trades, of which typical instances are toy and button making and weaving, the work is conducted at the home of the particular labourer, where the distributed power is utilised direct.

In considering the future of transmitted electric power and its bearing on industrial redistribution, it is not unreasonable to assume some such outcome as this, though on a larger scale, among the chief manufacturing trades of a country. The uprising of domestic labour for the lighter trades, assisted by improved electrically operated machinery, would conduce to a higher standard of worker and greater content in general. For the heavier engineering works decentralisation need not be carried as far as the home, but the necessity for congested areas would not be so great, and the most trying work could be conducted under greatly improved conditions.

The World's ELECTRIC PROGRESS

Editorial Commentary of the Month.

The Institution Visit to St. Louis.

OUR readers will already be familiar with the arrangements made by the Institution of Electrical Engineers for the visit of delegates and members to the International Electrical Congress to be held at St. Louis in September. As announced in our last issue, the Editor-in-Chief of this journal will accompany the party; and during the tour, which includes the most important manufactories and hydro-electric stations in the Western States and Canada, he will keep us posted on all objects of great interest. His chief observations, as we have already stated, will be extended over the state of the American electrical industry as presented in the various examples brought under his notice; and such deductions as he will make from these will be published for the benefit of British electrical men in general and our readers in particular. The work of our Editor-in-Chief in this respect will, we are convinced, be of material value to the electrical industry of this country; and representing that industry as we now do, his statements can be relied upon as conducing to the propagation of its interests in every possible way.

The St. Louis Exposition and the International Congress will naturally claim his chief attention. In regard to the former the Publicity Department of the Exhibition has been organised on so extensive a scale and the number of technical and popular journals is now so multitudinous that the Exposition and its exhibits even at this stage are becoming hackneyed to a degree. We have already noticed the Exposition and its objects in two illustrated articles, but have refrained from giving the orthodox descriptions so dear to the heart of the average periodical, preferring to wait till our Editor-in-Chief could send us across material which might be classed as presenting a new aspect of things. In this connection we hope to publish a comprehensive account of the most meritorious electrical features of the Exposition and the International Congress in an early issue.

The Prevention of Railway Accidents.

AMONG our special articles this month will be found one from the pen of Signor Attilio Beer, in which he describes an automatic electric system of his own invention, by the use of which he claims complete immunity will be afforded any railway from *running* accidents of all kinds. The system he describes is extremely interesting, and while we dare not prophesy for its future, it possesses merits which should attract the attention of railway companies. Readers will notice that it combines the features of an automatic signalling system proper, and those of methods adopted for apprising the driver in the cab of the state of the line ahead. Signor Beer's system has been experimentally tested in Italy on the Fanozlo section of the Padua Castel-Franco Line, with complete success, and we have before us a letter from Signor Galluzzi, manager of the Traffic Department, in which he speaks most favourably of the system and its working. In reading a description of any automatic signalling system, the reader, particularly if he be unacquainted with such devices, is apt to deduce undue complication from the arrangement, whereas if he actually inspected the apparatus in working form, its extreme simplicity would be at once apparent to him. When Signor Beer has installed his system, which we have every reason to believe he will, on numerous railways we shall be able to speak more emphatically of its merits, but for the

present we must be content with remarking upon its apparent simplicity and utility for its particular purpose.

Continents to be Sundered by Electric Power.

In this age of electric power we can afford to look back on the work of de Lesseps and his engineers on the Panama Canal, and calmly debate what his chances of completing so gigantic a work would have been, had he had the command of modern machinery and electric power. Investigation of his engineering methods points to the inadequacy of his machine tools to undertake the work, both from the matter of design, size, and efficiency. Now that America has the project in hand, the harnessing of the most modern horse to the plough which shall cut the isthmus is naturally to be looked for, and electricians may well feel proud that the bulk of the work in the way of the motive power and lighting will fall to their share. Already we have perpetuated the name of our great industry in many—nay, almost all branches of human activity—but what undying fame shall we not inherit from our part in this mighty scheme. The debt of electrical engineers to America is now great, but in her association of electric power with the Panama Canal—the completion of which will be greatly expedited by this means, they will remain eternally indebted to her.

We understand that the preliminaries preceding the actual commencement of work will occupy almost two years, but that active steps are now being taken to make these arrangements complete, beyond all possibility of breakdown as operations will be conducted in spots remote from all sources of engineering activity. As the facts regarding the progress of these preparations come to light, we shall record them in that particular section of the Magazine under which they would naturally fall.

British Association Annual Meeting.

The Annual Congress of British Scientists is to be held in Cambridge this year, and by the time this issue is in our readers' hands the Presidential address will have been delivered by the Prime Minister, who assumes the presidency on that occasion. We understand that despite the attractions at St. Louis, a goodly number of guests from all countries will be entertained, and audiences quite up to the usual standard are expected. The Engineering Section is under the presidency of the Hon. C. A. Parsons, and we shall look forward with interest to the papers read. It is improbable that anything very serious will be said on electrical subjects, though the Association has contributed many important papers from prominent electrical men to the current knowledge of the science.

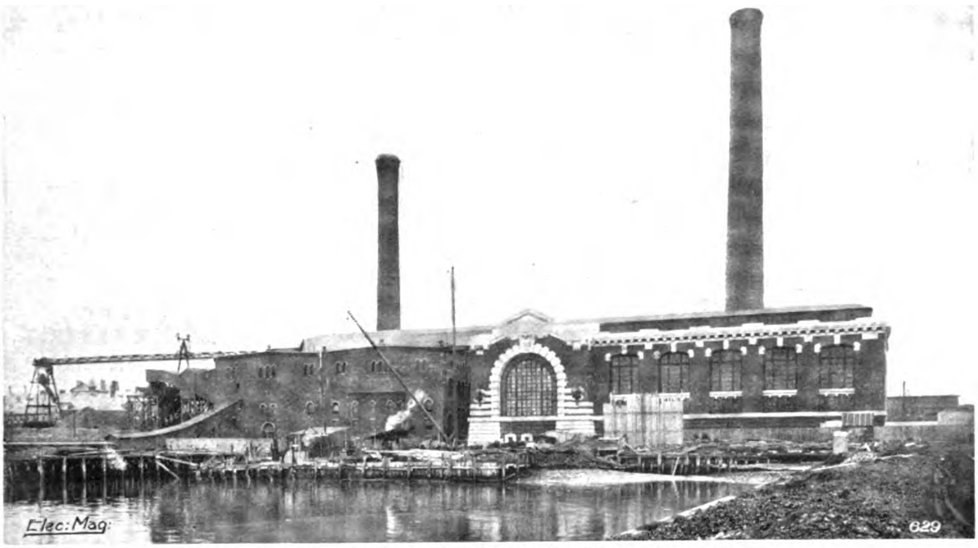
Motor Bus v. Tube and Tram.

The doom of the London omnibus, so emphatically pronounced on the opening of the tube lines to the City has not yet been sealed, if we are to be guided by a recent report of the London Road Car Company. As our readers are doubtless aware, this company has made several attempts to start motor-omnibus services on their routes, with a view to competing more closely with the tube lines. Doubtless they are encouraged in their efforts by its present prosperous condition, as evidenced by the greater number of 'buses they are now running. We understand these exceed all previous limits, and the circumstance affords striking proof of the public preference for open-air riding. It may, of course, be only a coincidence, but the accidents, some fatal, which have occurred on electric lines of all kinds probably find their reflex in this desire of the travelling public to avoid all risks. Reviewing the situation, if the service of horse-buses can successfully compete with the tubes, the prospects of mechanically propelled vehicles along the same routes would appear particularly rosy. Moreover, the continued desire of the omnibus company mentioned to establish such a service clearly testifies to a strong confidence in such vehicles and the results they will achieve. The merits of the self-propelled vehicle have long been recognised, and its ability to handle large quantities of people expeditiously is unquestioned, but so far the steam or electric 'bus has not captured the metropolis, in spite of several "excursions with alarums." Still, the

efforts of the indefatigable Road Car Company are to be commended at every turn, and we shall watch the effect of their "auto-'buses" on the tube traffic returns with considerable interest.

A Large American Steam Station.

THE vicissitudes, since their inception, of many of the early American Lighting stations are, in most cases, a concrete history of the development of dynamo electric machinery and prime movers, a history which, to the practised eye of one cognisant of the early types of apparatus, makes most interesting reading. Acquaintance with most industrial developments is usually made through the medium of the historian whose account of events, though instructive in a way, is apt to become tedious in perusal. In the cases to which we refer, however, your historian conducts you from station to station, advancing from the earliest types through the intermediary stages to the most modern product, the entire progress passing in review the examples of each epoch in a far more interesting manner than any written account. The stations of the Boston Edison Illuminating Company to which we refer in the Power Section this month, are typical instances of the advancing stages of power-house development from the earliest attempts at lighting a few arcs off separate machines, to the concentration of thousands of horse-power in a single unit now evidenced in the latest practice. Starting with a few arc lighters belt-driven from engines in the floor below, the concern has gradually been built up until it has acquired the entire rights of supply in and around Boston. The fine new L. Street station which we illustrate, has been designed on a colossal scale, and though but a few units will be installed at present, the ultimate capacity of the plant, 60,000 k.w., will be reached as extensions are demanded. Following up modern practice, turbines will be installed, and such monster units as 5,000 k.w. sets will be the only plants employed. What an extraordinary contrast to the tiny initial station which would barely furnish exciting current for one of the large units now erecting!



EXTERIOR OF BOSTON EDISON ELECTRIC COMPANY'S NEW POWER HOUSE.

Engineering Standards Committee.

IT is satisfactory to learn that the recent conference of tramway pole makers, held under the auspices of the Electrical Committee of the Engineer-

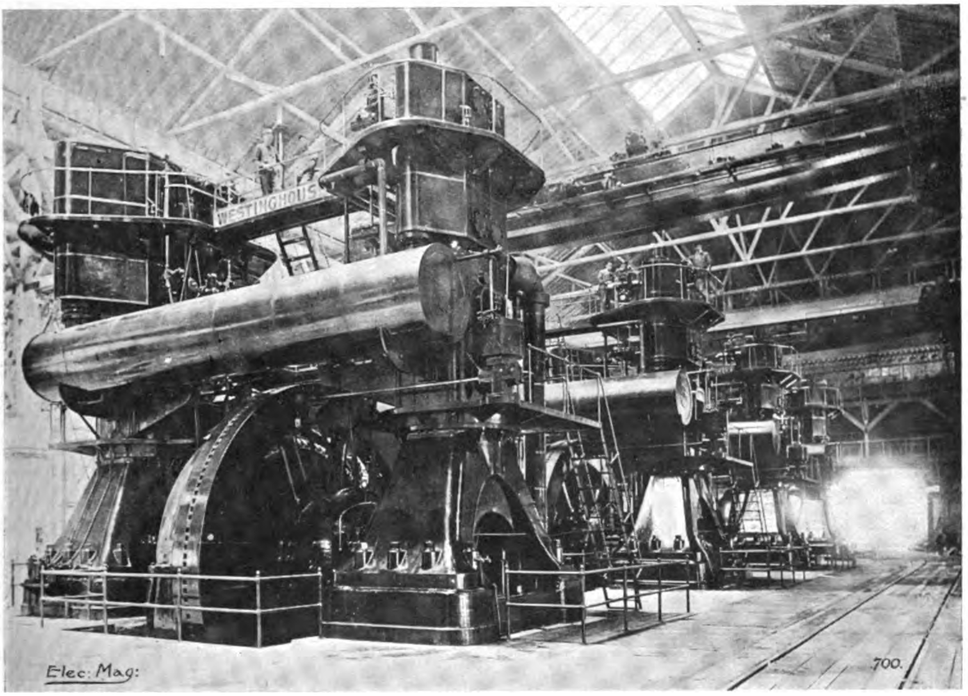
ing Standards Committee, has been in every way successful. The classification and over-all length of tramway poles, as well as the length of telescopic joints, proposed by the electrical sub-committee, received the approval of all those attending the conference. With regard to the diameters which the Committee had chosen to provide for interchangeability, there was some difference of opinion. It was contended, and not without reason, that the diameters selected did not represent the most economical construction, in view of the stipulated bending tests. As a result of the criticism evoked, we understand the Committee are now considering an increase of the suggested diameters. The practical information afforded during the conference should enable the Committee to revise their original proposals, so that the final standards may be thoroughly acceptable to all concerned.

Telegraphs in the Malay Peninsula.

THE rapidly increasing trade of this rich and productive country is one to make some of us at home feel rather jealous, but after all the United Kingdom benefits to the extent of 15 per cent. in the growing prosperity of the Malay Peninsula, for that is the amount (according to returns available) of the external trade in which we participate. Indirectly we are interested to a larger amount, for, out of sixteen and a quarter tons of shipping entering and clearing the ports, British vessels account for more than half. With Lahore and the Federated States of Peirak, Selangor, Negri Sembilan and Pahang, our own possessions of Singapore, Penang, Dindings, and Malacca, are increasing fast both in population and in trade. For the extent of country the former is still small, perhaps thirty to the square mile, and the trade surprisingly large by comparison, for in 1901 the value of imports and exports was sixty-six millions sterling. This with a population of one and a quarter millions gives a high average per head. The telegraphs within the Malay Peninsula are not so extensive as might be conjectured from the extent of the trade. It is not possible to state the number of miles of wire already put up with complete accuracy, but probably four hundred miles would be a fair estimate. For the railways perhaps a rather less mileage is in existence. So that much remains to be done in the way of development of these advisable public works. One very important step, and that is to place each system under a central administration of its own, for the time must come when there will be a network spread over the peninsula which will require uniformity of equipment and methods of working to render each as efficient as it should be for the public service. That has been recognised in India as a necessity for the telegraph system, and to a large extent the railway management of the Native States has been assimilated by that of British India. We should anticipate that the railways and telegraphs will grow rapidly in the Straits Settlements and States, and with the financial facilities available we should not be surprised to find them doubled in extent in the next ten years. Cable communication is good with India and Europe, as well as with China and the adjacent islands, so that wireless telegraphy has not yet taken root. This will come no doubt, as an auxiliary to the cables. As regards the products of the peninsula, tin is of course one of the chief, and also the indispensable gutta percha. In Selangor the cultivation of this tree has been taken up, and in Perak, rubber is attracting attention. Sugar, rice, tapioca, spices, hides and horns figure as the other chief exports. There are over seven hundred miles of telephone wire in the Straits Settlements, which belong partly to the Oriental Telephone and Electric Company at Singapore, and partly to the Government Exchange at Penang. The former have lately secured an extension of their licence for thirty-two years, so they are in a strong position, and doubtless the latest improvements will be introduced. As usual in the tropics the climate is much against the successful working of both telegraphs and telephones, but if the climate cannot be improved, the apparatus and circuits can, and they demand the highest standards of material and manufacture.

Service Plant at St. Louis.

To furnish light and power to so vast a number of buildings as are assembled in the St. Louis Exposition grounds naturally requires power-units of considerable size. Since electric lighting became popular, and ultimately essential, in exhibitions of this character the necessary plant was generally representative of the design of machine commonly installed at that particular time. The plant at St. Louis, a portion of which is by the Westinghouse Company, comprises slow-speed vertical corliss compound engines driving a centrally placed generator direct. We illustrate the four units installed, and it is interesting to note that they each exceed in capacity by almost three times the units installed by the same company at the Chicago World's Fair in 1893. The four sets, which are each of 2,000 k.w. capacity, may be said to represent a large type of combined unit, which is doing remarkably good service in various makes and sizes all over the world. The popularity of the cross compound vertical combined set is not entirely due to the economy in floor space it afforded over its predecessors, but to its high efficiency and general reliability. The comparative absence of the steam-turbine among the service units will probably be explained by the fact that when the plant was commissioned the turbine had not been developed to the extent of its being employed in sizes large enough and in the time specified for the particular purpose. The next World's Fair, if held in America, or any other country, will doubtless point to the compound vertical engine and dynamo as bygone giants, useful enough in their day but not fitted to enter that epoch in power-unit design which will demand economy of material, floor space, and attendance, in addition to efficiency and reliability.



SERVICE POWER PLANT AT ST. LOUIS.

More Light, Less Crime.

WHATEVER may be its failings, full justice has yet to be done the street arc lamp as a check on crime and criminals. Police officials and statisticians are silent as a whole in giving credit to this silent nocturnal guardian of public property,

this champion of civic integrity. It remains for some isolated though exalted functionary to raise his voice in giving credit to the "father of electric lights," and his work in cities, of damping the ardour of would be criminals. Police Commissioner McAdoo of New York has recently remarked on lighting the streets in that city, "I have always believed that light would prevent a great deal of disorderly conduct at night in certain streets. I do not believe there is anything which would rid us of illegal resorts and clean up certain streets as would light. If I had charge of lighting New York as well as protecting it I would at least double the light. I know of a place before which a big light was put. The proprietors practically got down on their knees to have it removed. I would apply the light remedy." Our esteemed contemporary, *Electricity*, New York, in remarking upon the arc lighting of that city attributes its success to the use of the enclosed arc. With the open arc the lamps can be readily blown out, but enclosed lamps stand up to the weather, and their controlling mechanism being simpler, can be better relied upon. We need some authoritative statement from our chief custodians on the subject of electric street lighting and its influence on crime. The east end (London) stations have been running some time now, and there is ample opportunity for collecting evidence. With this as with many other things we repeat, "Let there be light."

Government and the Telephones.

At the present juncture, when the terms upon which the State will assume charge of all public telephone services is under consideration, it is of interest to read in the Postmaster-General's Report for 1903, that at the end of the year 1899 a more active policy was initiated by the Government Department in obtaining fresh subscribers. The increase in four years was due not only to the establishment of exchanges in places not served by the National Telephone Company, but also to the growth of the business in those areas in which the Company and the Post Office have been in active competition. In the South Wales district for instance, where the number of Post Office subscribers was only about 370 at the end of 1899, the number has now increased to 2,255. In London, of course, with the Central and six other exchanges, the increase was very large, the number of telephones added in 1902–3 being 8,628. It is believed that this number has not been exceeded during the first year of working of any other local telephone system. We are inclined to think that the growth of the Government business will operate rather to the disadvantage of the company if the latter is bought out, owing to the modifications thus effected in the assessment of "good-will," which will be taken into account in making the award. Another feature likely to influence present value is the possible future reduction in telephone rates.

One-Phase Railway Experiments.

Our readers have already been kept posted in the latest development of 1-phase railway motors and systems, in Mr. W. M. Mordey's articles on the subject. We may mention incidentally that the next instalment has been held over from the present issue and will we hope appear next month. The Finzi system which was tested on the street railway lines of Milan late in 1902, is, we understand, shortly to be given a trial on the Valtellina railway. The Societa Ital ana per le Strade Ferrate Meridionali, which at present operates this important line, has consented to make these tests as a comparative experiment with its 3-phase system.

Our readers will remember that the Valtellina line is the only one operating with 3-phase currents under the latest high-tension conditions and the results obtained since the opening of the line some twelve months ago have been highly satisfactory. The Finzi system has been chosen after a careful comparison of the various 1-phase railway methods suggested by different firms. In conducting the tests a standard motor-car, as now used for 3-phase currents, will be fitted with four 1-phase motors of 100 h.p. each, at 200 to 400 volts, and the necessary controlling apparatus. The line voltage of 3,000 will be employed, and the motors will have no rheostat controllers of any

kind. The trial car will, we are informed, be expected to haul a standard 100-ton train from Lecca to Sondris at a speed of forty-five miles per hour. The results of these tests will be watched with the keenest interest by electric railway engineers, and as occasion arises we shall give due prominence to them in our columns. We must congratulate the company on its active spirit in endeavouring to secure the best possible system for operating its line, and doubtless if the experiments prove successful they will take steps to bring about a conversion at an early date. With the hydro-electric resources of Italy, and other countries for that matter, in contemplation, the impetus given to 1-phase traction by such a proceeding would be great indeed.

Physics and Faith.

OUR contemporary, *The Electrical Review*, New York, makes some very interesting remarks on the question of N-Rays that we think them worth quoting verbatim. "The rapid progress which is being made in the study of the numerous types of invisible radiations and emanations which have been described, and the discovery every little while of some new type, have put a considerable strain upon the faith and imagination of the average man. Becquerel's discovery of the radiation from uranium attracted but little attention except from the scientific, but it led to the discovery of radium, which caused a sensation almost as great as that created by Röntgen's announcement. Since then it has been shown that these radio-active phenomena are quite complicated, and that there are many substances which have this property.

"The scientific have found an entirely new field for investigation opened, and have also found opportunity for instructive controversies, not only as to the nature and cause of these radiations, but even as to the existence of certain types. When Blondlot first described that radiation which is particularly identified with his name, and which, in honour of his university, he called the N-ray, it would seem that unwittingly he had selected an exceedingly appropriate designation, for in mathematics N is used to signify an indefinite number, and M. Blondlot already claims to have identified three different forms of radiation, and more will doubtless follow. The first discovery was called the N-rays, but as many physicists were unable to repeat satisfactorily the experiments which Blondlot described so carefully, the latter in repeating certain of his earlier experiments discovered the N-rays, which, while in some way similar to the N^1-rays, in other respects have a directly opposite effect. M. Blondlot has now discovered a third radiation—or what is more properly called emanation, since the term "radiation" is now limited to mean either energy waves, such as light and heat, or small particles of matter shot off at exceedingly high velocities, and the new discovery seems to be either a very heavy gas or matter in some ponderable form, as it falls in a vertical direction from the body giving them off. From the frequency with which new discoveries in the field of radio-activity are made, one is led to the belief either that many things—perhaps nearly everything—is a source of radio-activity, or that the different phenomena observed are due to but a few causes, which may be somewhat removed, but which will be identified upon further investigation. In the meantime, one's imagination is being exercised, and we are being prepared for whatever wonderful discoveries may be made in the next few years. No doubt all this is excellent training for the mind; and if one's faith is balky occasionally, some comfort may be drawn from the thought that, at the present rate of progress, it will not be long before we shall know much more than we do at present about these surprising things, and that a great deal of what is now cloudy and indefinite will then become clear and understandable."

SPECIAL ARTICLES

LONDON POST OFFICE TELEPHONE SYSTEM.

By W. NOBLE, A.I.E.E.

ALTHOUGH at the time of the inauguration of the Post Office Telephone Service in London about two and a half years ago, a more or less full description of the internal work of the Central Exchange was given in several technical journals, strangely enough the external work of the system has never been more than briefly mentioned. To the Telephone Engineer the outside work is equally important with the inside, and as the methods adopted have stood the test of time, the present is an opportune moment for an examination of the details. As the work has progressed certain developments have become necessary both in the external and internal work.

Central Exchange.—In the Central Exchange the full equipment of the first part has just been completed by the Western Electric Co., and it is now capable of accommodating some 14,039 subscribers. The same Company have begun the construction of the second portion of the Exchange, which will provide for about 16,000 additional subscribers. It is anticipated that the extension will be completed early in 1905. Fig. 1 shows a plan of the Switchroom in its finished state. The room has now a particularly fine appearance, although a large recess breaks the continuity of the switchboard on the east side. The length of the switchboard for subscribers' circuits is 178 ft. 5 in., that for junction lines 128 ft. 4 inches, or a combined total of 306 ft. 9 in.

Fig. 2 gives a back view of the subscribers' board. It illustrates a length of about 93 ft., showing the 63-wire multiple cables, the height of the group being 36 in. and the depth 18. Underneath these cables may be seen (also running horizontally) the outgoing junction multiple cables; the home section cables from the Intermediate Distribution Frame (shown as issuing vertically from chasing); whilst the clearing relays and resistance spools are also to be seen.

Subscribers' Lines.—The growth of the Central Exchange has been most satisfactory. In April 1902, when it was opened, the number of subscribers was only about two hundred. The number of direct lines at the end of June this year was just over 9000, in addition to which there were several thousand extension lines, making altogether about 12,000 stations. Thus the principal Government Exchange is already more than double the size of any other London Exchange, and the number of subscribers is steadily increasing.

Junction Lines.—In addition to the subscribers' lines, junction lines connect the Central to the other Post Office Exchanges as well as to the various Exchanges of the National Telephone Co. These lines already number about 1100, and they are being added to as the Post Office system develops.

Making a "Solid" Joint.—An interesting

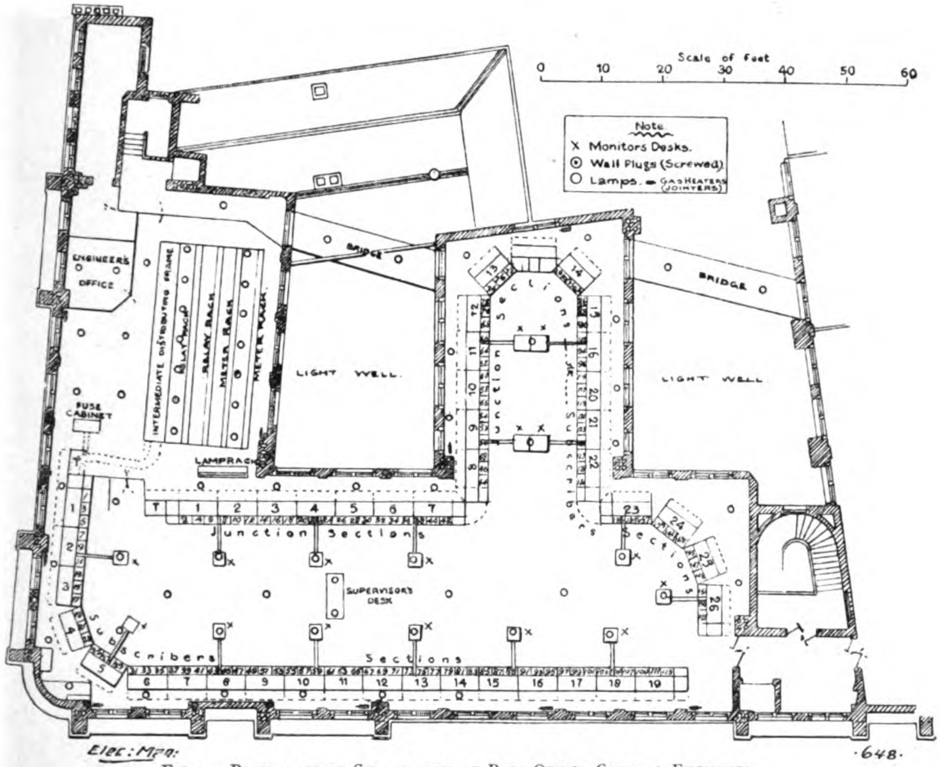


FIG. 1. PLAN VIEW OF SWITCHROOM OF POST OFFICE CENTRAL EXCHANGE.

item of inside work is the method of making solid the joint between the outside cables (paper core) and the inside cables (silk and cotton core). The main paper core lead-sheathed cables, with external diameters of from 2.65 to 2.85 inches, enter the sub-basement of the Exchange from two routes of conduits, and are carried on iron bearers (*see* Fig. 5) on which they are jointed to the silk and cotton-core lead-sheathed cables having an external diameter of 1.75 inches. The sleeve covering each joint is filled with a hot insulating mixture (composed of twelve parts palm pitch, four parts ozokerite and one part Stockholm tar) so as to form a solid or "pothead" joint to prevent the ingress of moisture to the paper-core cable. The common method of filling a pothead joint is to repeatedly warm the sleeve and pour in the hot compound until the sleeve is apparently full. This process usually occupies about three hours, and however carefully executed is seldom perfectly satisfactory. The Post Office has adopted a method of filling a joint by forcing the compound

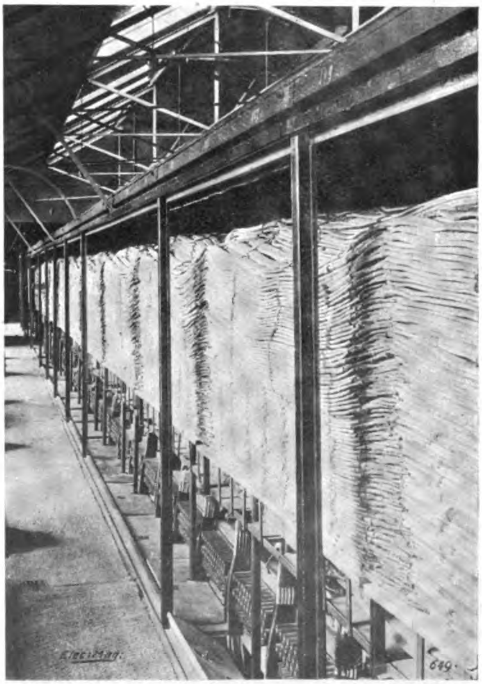


FIG. 2. BACK VIEW OF SUBSCRIBERS' BOARD SHOWING A LENGTH OF CABLE RACK.

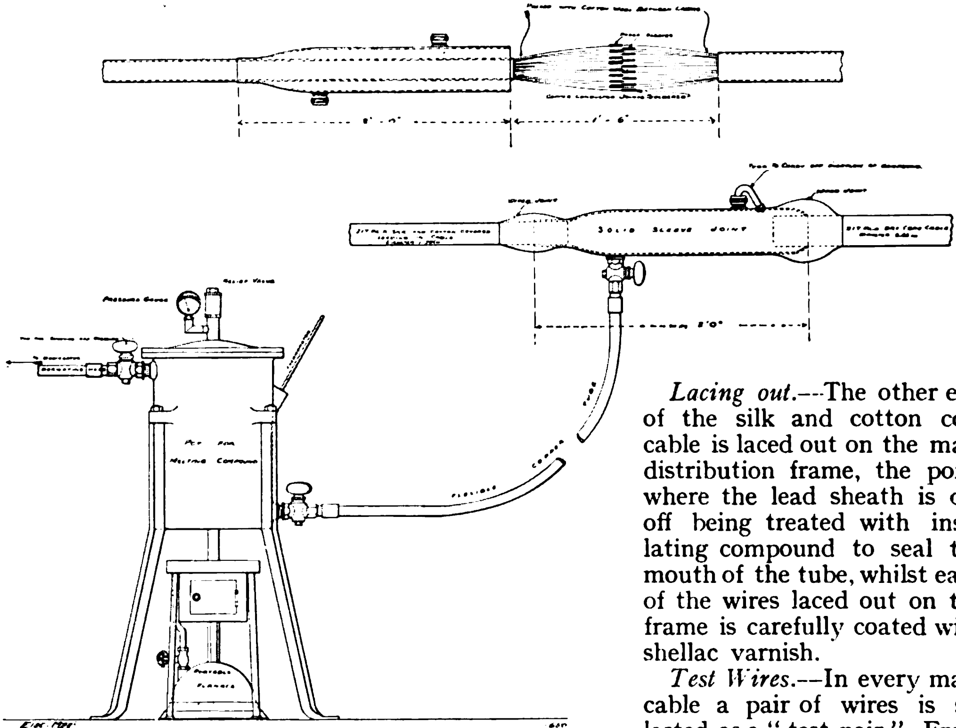


FIG. 3. METHOD OF MAKING SOLID JOINT AND APPARATUS FOR FORCING IN COMPOUND UNDER PRESSURE.

into the sleeve by means of air pressure. Fig. 3 illustrates the process. The lead sleeve for the joint is provided with a screwed nozzle above and one below. To the lower one is attached a flexible metal tube leading to a vessel containing the compound which is kept at a temperature of 200° Fahr. by means of an oil furnace. The connecting tube and the sleeve are kept warm by means of Swedish torch lamps, whilst the compound is forced into the joint at a pressure of 20 lbs. After an application of pressure for about four or five minutes only, the compound issues freely from an overflow tube screwed into the nozzle in the upper side, and the pressure is maintained for about thirty seconds after this occurs, the overflowing compound being collected in an iron vessel for further use.

Experimental joints filled in this manner, when cut open, showed that the compound filled every part of the joint. It is prevented from penetrating beyond the sleeve in the usual manner, namely, by packing each side of a joint with cotton wool.

Lacing out.—The other end of the silk and cotton core cable is laced out on the main distribution frame, the point where the lead sheath is cut off being treated with insulating compound to seal the mouth of the tube, whilst each of the wires laced out on the frame is carefully coated with shellac varnish.

Test Wires.—In every main cable a pair of wires is selected as a "test pair." From the point where they issue from the lead sheath the two wires are taken direct to two insulating pins. They are taped throughout by rubber so as to ensure good insulation. A monthly test is made of these wires and any loss of insulation in a cable is thus promptly checked.

Desiccating Apparatus in Exchange.—In the sub-basement of the Central Exchange special plant is fixed for raising the insulation of cables by desiccating them by dry air. The installation, shown in Fig. 4, consists of a motor-pump and seven cast-iron cylinders, the dimensions of which are given in the drawing. The first six cylinders are filled with "fused" calcium chloride, while the lower half only of the seventh is similarly filled, the upper half being loosely packed with medicated cotton wool. The object of inserting wool is to prevent particles of dust or calcium chloride from entering cables. An outlet for the dry air pumped into a cable is provided at the distant end. Every cable terminates in a Cable Distribution Head (to be described later), and in this head there is a screwed nozzle, fitted with a cap. By removing the cap the air escapes, and

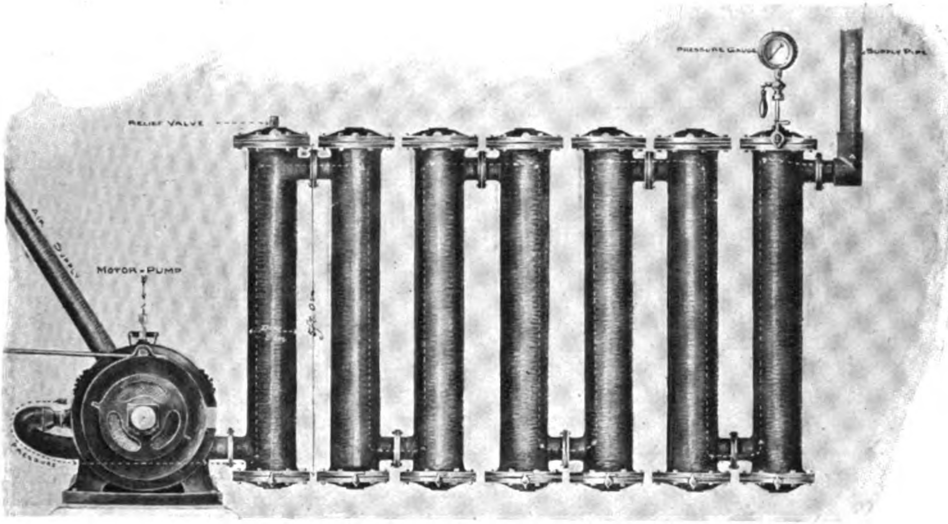


FIG. 4. DESICCATING APPARATUS AND ACCESSORIES AT THE EXCHANGE.

to indicate whether any loss is occurring in the cable a gauge can be inserted in the nozzle. The air pressure usually applied to a cable is from twenty to twenty-five lbs. per square inch. Fig. 5 shows how the desiccator is connected to each cable. By means of suitable cocks dry air can be passed into a group of cables or to any one singly.

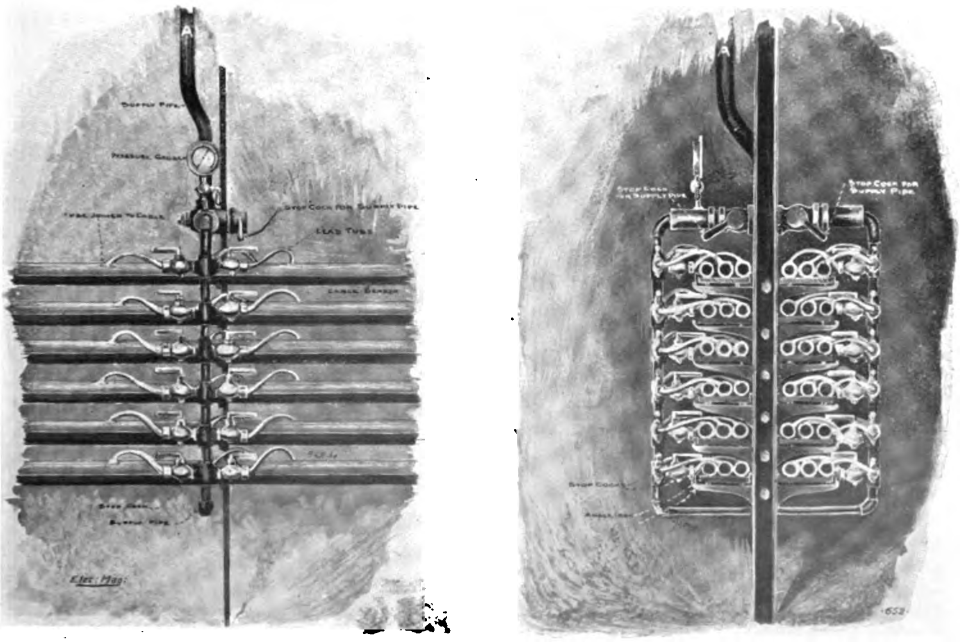


FIG 5. METHOD OF CONNECTING DESICCATOR TO EACH CABLE.

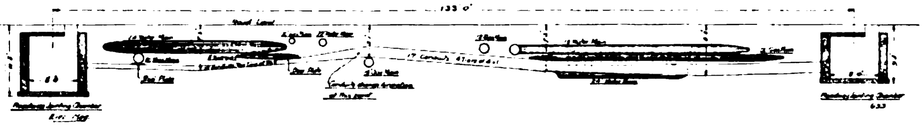


Fig. 6. Section Through Excavation for Seventeen Ducts in Oxford Street.

Dusting by Dry Air under Pressure.—One other use to which the desiccator is put is that of dusting. A system of one-inch wrought iron pipes is carried round the switchroom and the test rooms. At suitable points in the pipes T-pieces with cocks are fitted, and to these flexible tubes can be attached as required. Each tube terminates in a brass nozzle with small orifice and tipped with an insulating substance. With dry air at a pressure of 20 lbs. the dusting of the distribution frames, the back of switchboards, relay racks, and other pieces of apparatus is carried out quickly and thoroughly.

Underground Works.—The telephoning of Central London, above all other cities, by exclusively underground cables, was a great undertaking, the difficulties of which can be appreciated only by those electrical engineers who have had to put down lines in its crowded roadways and still more congested footways. And not less difficult was the work of casing and wiring large City buildings, the basements and corridors of which were already alive with electric light, gas, water and hydraulic services.

An illustration of obstructions to conduit-laying may be of interest. Fig. 6 shows a section of a trench excavated in Oxford Street by Tottenham Court Road for the laying of seventeen conduits.

In most cities of every other country where underground work has been resorted to, it has been only a partial system, so to speak, the main cables being underground and the services overhead. In Brussels, for example, this system has been much developed, the central part of that city being divided into a number of areas, each with a radius of about two hundred yards. A cable is laid to the base of a ground pole (or "Tour," as it is called by the Belgian authorities) erected near the centre of each area. These poles have a striking appearance, being made of iron lattice-work, and having a height of about 103 feet. In the base of these towers accommodation is provided for terminating the paper-core cables and for fixing lightning protectors, heat coils, and fuses. Each pole is capable of distributing 400 wires. Standards on buildings are largely used in a similar manner.

If in London underground work was difficult, overhead work was impossible. When the Post Office mapped out its plans for telephoning London, all the suitable air space was already occupied by the National Telephone Co., and thus underground work, with all its difficulties and great first cost, had to be faced without alternative.

Conduits.—In 1900 the Post Office carefully considered various classes of conduits, and eventually adopted the single earthenware duct illustrated in Fig. 7. It has proved eminently satisfactory. As against multiple ducts, the single duct has the advantage that it lends itself readily to a change in formation of the grouping without the intervention of a jointing chamber; and, further, single ducts can be connected to cast-iron pipes when it is necessary to resort to these on account of obstructions necessitating shallow depths. An interesting example of such changes in a line of ninety conduits in Queen Victoria Street may be cited. In this case, on account of underground obstructions, in a short length of 137 yards, the conduits had to

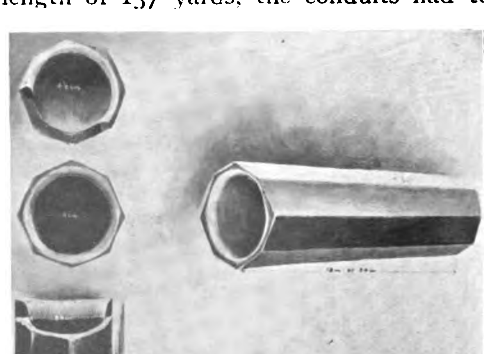


Fig. 7. Standard Earthenware Duct Adopted by the Post Office.

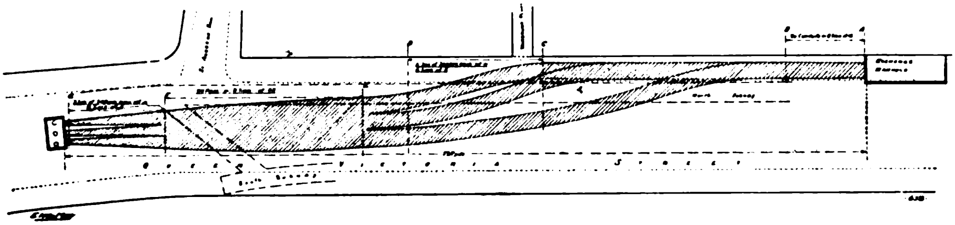


FIG. 8. VARIOUS FORMATIONS FOR A LINE OF NINETY DUCTS IN QUEEN VICTORIA STREET.

be laid in the various formations shown in Fig. 8. From the large jointing-chamber in front of the General Post Office, South (in the back building of which the Exchange is situated), ninety ducts issue in one group of six tiers of fifteen; these being divided up, at different points a short distance apart, into three sets of 3½-inch cast-iron pipes grouped in six tiers of five. These three groups "fold over," or interlace, into one nest of two layers each of forty-five pipes, which again split up into three sets of thirty, in six tiers of five.

From the west side of the large jointing chamber in which the pipes terminate, ninety ducts emerge in three nests, each in six tiers of five, and these coalesce into one set of nine tiers, each of ten ducts; and this group is again altered to one of six tiers fifteen wide. Needless to say the underground obstructions on this route were very difficult to negotiate. There is a subway on each side of the thoroughfare, with a connecting subway near St. Andrew's Hill. The roof of the latter approached within fifteen inches of the roadway surface, and the brick arch had to be replaced by steel troughing, over which the ninety pipes were spread out, as already stated, in two rows of forty-five each. Another instance of "folding-over" of ducts occurred in the length of work illustrated in Fig. 6, where seventeen ducts issue from the east manhole in five tiers and extend to the west manhole in two layers.

The connection between earthenware ducts and cast-iron pipes is made by means of a special coupling piece, one end being octagonal in shape and of similar dimensions to a duct, the other end having a spigot or a socket, as required, to fit the pipes.

Conduit Laying.—The earthenware ducts are built up on a concrete foundation of six inches, in the centre of which are embedded steel T-irons, bolted together. The object of the T-irons (which are 2½ in. by 2½ in. and ¼-in. thick, with a tensile strength of 27 to 32 tons per square inch) is to resist the vertical displacement of the conduits. The number of T-irons used depends on the formation and size of a group of ducts. Thus, for eighteen ducts in six tiers three-wide, one T-iron is used; but if wider tiers have to be resorted to, two T-irons are employed. Beyond eighteen ducts two T-irons are used for groups up to sixty, laid in normal widths not exceeding eight ducts per layer. For sixty or more ducts, or where widths of tiers are abnormal, each case is considered on its merits. The concrete foundation having been allowed at least twelve hours to set, the first tier of ducts is laid, carefully bedded in about half an inch of cement-mortar. The second and subsequent tiers are similarly constructed, the interstices between the layers of ducts being filled

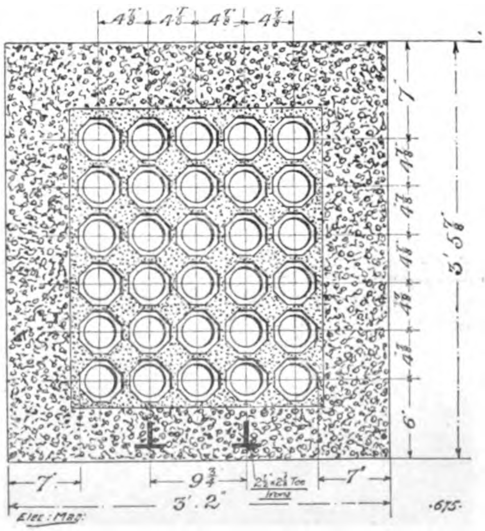


FIG 9. SECTION THROUGH A THIRTY DUCT LINE.

with cement. On the completion of each tier of ducts (the average length laid at one time being thirty to forty yards), the spaces between the outside of the conduits and the side walls of the trench are filled in with concrete, the spaces so filled measuring four to seven inches on each side. After the cement on the top tier has set, a layer of four inches to seven inches of concrete is filled in over the whole structure, which thus forms a compact mass. The thickness of the side walls and of the top layer of concrete depends on the class of paving in the thoroughfare in which the conduits are laid. For example, the thickness allowed for a wood or asphalte-paved street is four or five inches, as under both these classes of paving there is already six or more inches of concrete, whereas on a macadam-paved road a thickness of six or seven inches is allowed. Fig. 9 shows a section of a thirty-duct line. The normal depth at which ducts are laid is three feet from the roadway surface to the upper side of the top tier of conduits.

Jointing of Ducts.—As a means of jointing the ducts, a strip of prepared calico, 20 in. by 4½ in., is wrapped round the two abutting ends, half the width of the strip being on each duct. The surface of the calico being adhesive, on account of the ozokerite preparation in which it has been soaked, a good joint is made.

Throughout the operation of duct-laying a wooden mandrel, 11 in. long and of 3⅛ in. diameter, is inside the ducts, one half in each of two abutting ducts, to ensure perfect alignment and that the edges shall not project so as to reduce the available internal diameter of the conduit. A train of not less than twelve mandrels is used, and these are left in a line of conduits throughout its construction from jointing-chamber to jointing-chamber, being drawn forward as the work proceeds.

When a work is in progress, each morning, before the building of the ducts is resumed, the train of mandrels is drawn once backward and forward through the section so far completed to ensure that the alignment has been maintained. Further, on the completion of a length of conduits, and after the two manholes in which they terminate are completed and all ground filled in, a mandrel 9½ in. long and 3⅛ in. in diameter is drawn through each conduit, followed by a mop of white spun-yarn, the latter being twice passed through to remove any moisture or cement which may have entered.

One other point may be referred to before leaving the subject of conduits. The Post Office at the outset of the works found that the economical dividing line between the earthenware duct and the cast-iron pipe was five conduits. When five-ways or fewer are required, cast-iron pipes are used; beyond this number, ducts are employed. For six or more ways, ducts are more economical in cost and space occupied than pipes.

W. Noble

(*To be continued.*)

AN AUTOMATIC ELECTRIC SYSTEM FOR THE PREVENTION OF RAILWAY ACCIDENTS.

By ATTILIO BEER.

THE system here described has for its object the prevention, by means of mechanical and electrical apparatus, of accidents of any kind to trains, either whilst running on the line or on entering stations. The apparatus is automatically operated by the rotation of the two lugs of a rail contact device, this turning movement being determined by the pressure exerted by the wheels of the train or by a shoe attached to the locomotive. The rotation of these lugs in the direction of the train's travel causes the opening and closing of certain circuits connecting the contact and the electrical devices in such a manner that the position of the latter depends upon the movement of the train. The electrical apparatus in turn, acts upon mechanical devices so placed as to give sure and suitable indications of every train in motion, whereby all the trains are automatically protected as a result of those movements.

Human assistance is not required for working the apparatus, consequently with this system all possibility of false indications is entirely obviated. In describing the apparatus, reference will be made to the diagrams reproduced and to the lettered parts thereon, but to make the account interesting to the electrician having no affair with automatic electric signals, but desirous of making some acquaintance therewith, the names of the parts will be chiefly mentioned. Engineers who have studied the question will, it is hoped, have no difficulty in tracing the functions of the various parts by this means.

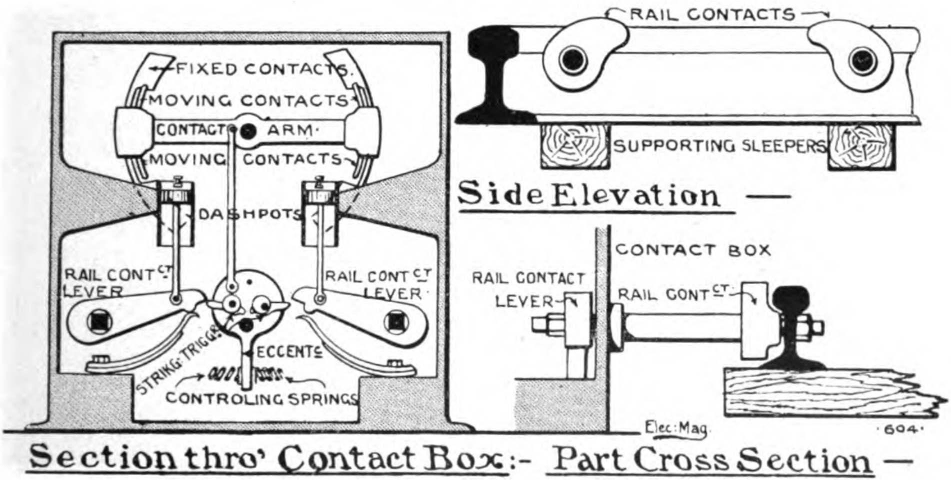


FIG. 1.
VIEWS OF RAIL CONTACT AND CONTACT DEVICE OPERATED THEREFROM.

The rail contact (Fig. 1) consists of two pawls connected to gudgeon pins; these latter enter holes in the channelling of the rail, a support being placed in a metal box containing the entire apparatus for opening and closing the electric circuits. Where the rail is weakened by the passage of the gudgeon pins, it is supported by an additional sleeper. The pawls connected respectively to the gudgeon pins rotate the latter when the wheels of the train or the shoe of the locomotive pass over them. If the wheels or the shoe act first upon the left-hand pawl the gudgeon rotates with the rail contact lever to be seen in Fig. 1. The end of this lever strikes a trigger, thus turning the eccentric and causing the connecting

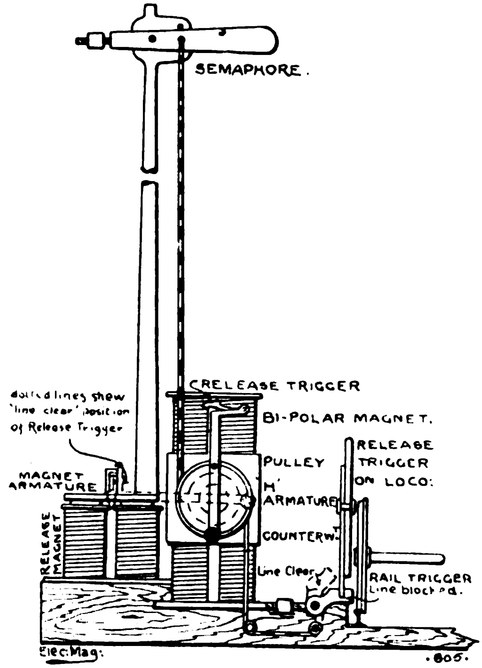


FIG. 2.
RAIL TRIGGER AND SIGNAL APPARATUS.

rod to act upon the contact arm, which is either raised to the right or lowered to the left. On the ends of this lever are fitted four moving contacts, the top set of which, when the lever is horizontal (the inoperative position), will be in circuit with the top fixed contact blocks, whilst the lower set will be cut out of circuit. When the wheel, or shoe, of the locomotive passes over the right-hand pawl, it rotates its pin and thereby moves the corresponding rail contact lever in the box, but the end of the lever will have no action upon the eccentric, because the left lever will have already caused it to rotate and the trigger, which has just been raised, will be out of action.

After the train has passed, the eccentric is returned to its normal position by controlling springs, whilst other springs return the rail contact levers to their original position. Two dashpots are provided to damp the return of the pawls and their attendant levers. The eccentric is not moved when the levers return, as the triggers only operate when pressed downwards; in returning the levers slightly raise them in passing, but nothing more. The rail contact, by closing certain circuits, operates an apparatus (Fig. 2) consisting of a bi-polar electromagnet, between the polar extensions of which there rotates an H-armature fitted with a pulley and operating cord. This serves to move the rail trigger from the horizontal position to that shown by the dotted lines.

This rail trigger is one of the chief features of the apparatus, as by it the exact state of affairs on the line ahead is communicated to the driver on the locomotive.

In its horizontal position this trigger stops the train by opening the Westinghouse brake or by operating the whistle of the locomotive, whilst in the vertical position it gives no signal to the locomotive and allows the train to continue its journey in safety.

The pulley has a projection carrying a release trigger, and when the movements of the contact device close the circuits of the magnet and its armature (the counterweight being downwards). the electromagnet and armature will acquire contrary polarities, so that the latter is compelled to turn to the extent of 90 degrees and taking the pulley and release trigger with it. The release trigger in its rotation (to the left), owing to the flexibility of its fixing, passes beneath a catch under the magnet armature, and stops in that position. The catch is merely an extension of the armature of the release magnet, the circuit of which remains normally closed by means of a contact device.

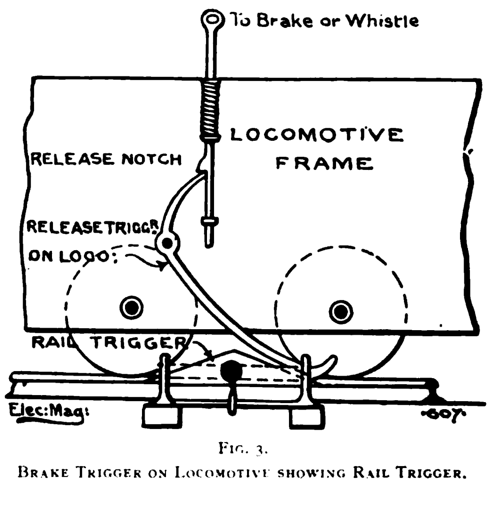


FIG. 3.
BRAKE TRIGGER ON LOCOMOTIVE SHOWING RAIL TRIGGER.

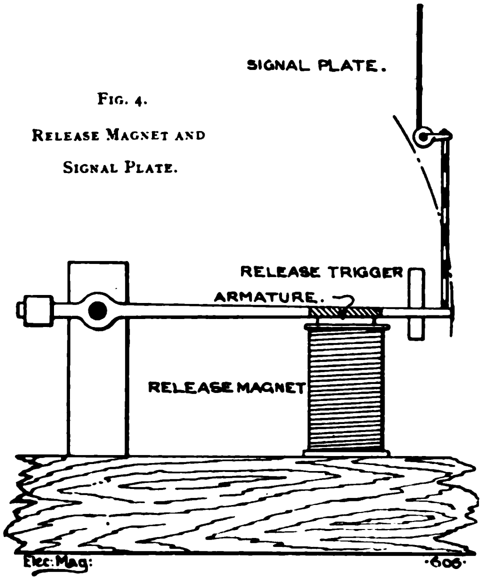


Fig. 4.
Release Magnet and Signal Plate.

We now get a position (line blocked) in which the movement of the levers of the contact device breaks off the circuit of the release magnet. When this circuit is opened from the contact box the magnet armature is no longer attracted, and, rising by the action of a weight at its other extremity (Fig. 2), permits the release trigger to rise also when the counterweight, H-armature, and pulley then return to their original position, the cord or chain releasing the rail trigger which falls by gravity to a position—" line blocked." Upon the passage of the train a trigger on the locomotive coming in frictional contact with the rail trigger, trips out of the notch made in the brake rod, a spring on the latter causing it to descend and open either the valve of the whistle or the Westing-

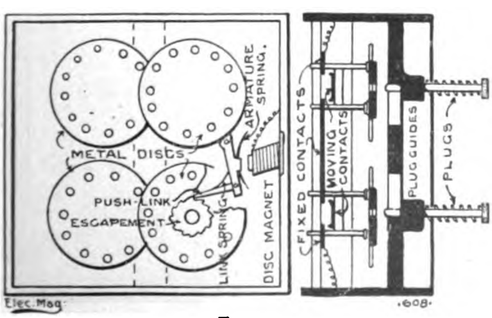


Fig. 5.
Disc Magnet Box for Stations.

house brake (Fig. 3). As an indication to the driver to stop the train before reaching the apparatus shown in Fig. 2, the pulley (in that apparatus), by the aid of a chain, operates a semaphore visible from a distance, and causes it to take up a position corresponding to that of the rail trigger. *i.e.*, the signal-arm falls for a clear road, and returns to a horizontal position to show that the line is blocked.

The rail trigger assumes the horizontal position either from a momentary interruption of the current (showing that the line is blocked), or, if there is no supply of current at all. In order that the driver may know definitely if the

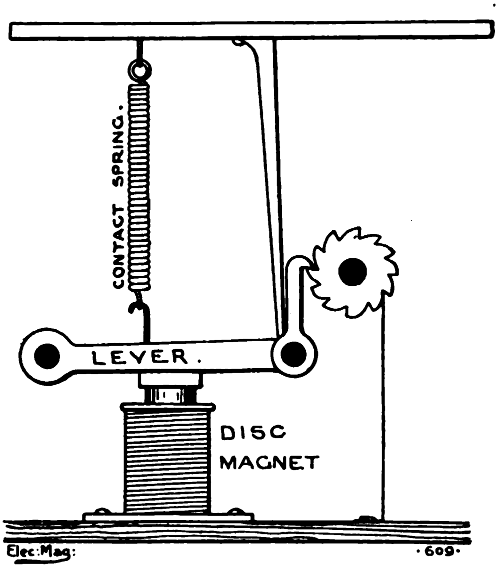


Fig. 6.
Contact in Stations controlled from Disc Magnet Box.

whistle or Westinghouse brake has been operated from the existence of some real danger or if it is caused by the failure of the current, he must observe the position of the signal plate forming part of the signal apparatus shown in Fig. 4. If this plate is in a vertical position, it indicates that the line is absolutely blocked, but if it is horizontal, it signifies that the current is interrupted. In this latter case, the driver may carefully continue his journey to the next station. Fig. 4 shows the mechanism which carries this signal plate in the vertical position. The plate is attached to a short bell crank lever, loosely

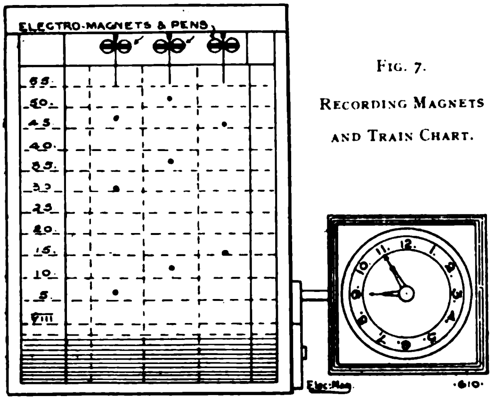


Fig. 7.
Recording Magnets and Train Chart.

pivoted to which is a rod resting on the end of the release magnet armature. The movement of the latter determines the position which the signal wi l take up.

The rail contact device described above not only works the apparatus but also operates another electrical device intended to be placed in an office at the stations. This device prevents any employée starting the train at the wrong time—*i.e.*, it is absolutely impossible for any one to allow the train to leave the station unless the line is absolutely clear.

This apparatus consists (Fig. 5) of four metal discs, keyed on four parallel shafts, each having a small escapement wheel. As each tooth of the small cog-wheel is released, the disc mounted on the same shaft turns through a constant angle. The discs over ap each other and are in different planes. Each disc has holes numbered consecutively to correspond to the teeth in the escapement wheel. These holes are so arranged that, for example, those of the upper discs do not coincide with those of the lower ones unless they are in a superimposed position in relation to the holes bearing the same number. To each escapement wheel there belongs a push-link connected to the armature of an electromagnet, termed the disc magnet. This armature is attracted when the circuit of the electromagnet is closed by the rail contact device. It causes the push-link to move back over the escapement and drop into the next notch of the latter. When the contact device cuts off the current, the armature is returned to its original position by a powerful bent spring, carrying the push-link and escapement with it for a distance corresponding to one hole and number.

In the box containing the four discs and in a space (shown by the dotted lines in left-hand view, Fig. 5, by two parallel dotted lines), there is arranged a frame carrying three fixed contacts, and in front of these two moving contacts or bridge-pieces. The fixed contacts form part of a circuit working rail trigger (Fig. 2) placed outside the points, just where the line leaves the station, to show that the line is clear.

The circuit is only closed when the two upper contacts come simultaneously in contact with the lower ones, and the upper contacts can only be closed when two plugs are pushed through the holes in the two sets of discs and press the contact bridges into contact with the

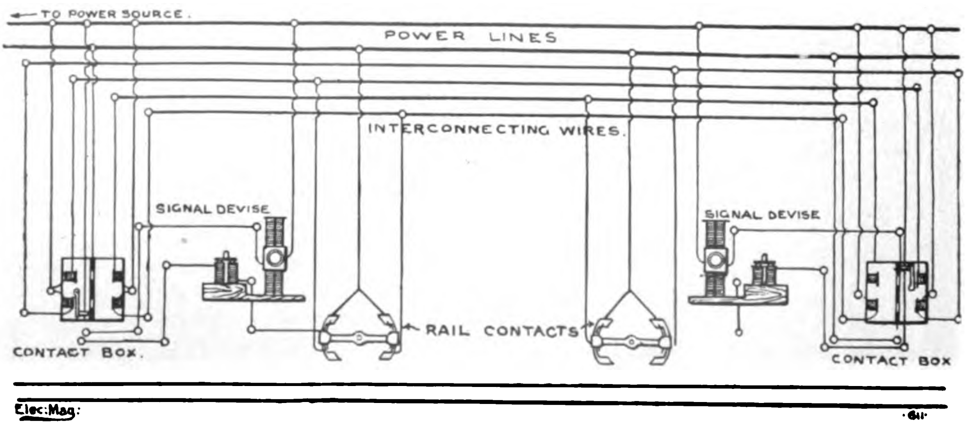


Fig. 8.
Diagram of Connections for Two Stations, showing Apparatus used in each Case

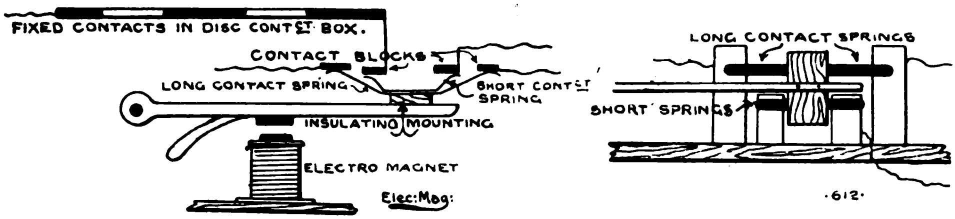


FIG. 9.
SAFETY DEVICE USED IN CONJUNCTION WITH DISC MAGNET BOX.

fixed contacts in the box. Two coiled springs placed upon each of the two plugs remove them from the holes directly the pressure placed upon them by the employée is released. The two plugs are supported in two long guides, which insure the correct alignment between the plugs and the holes in the discs.

To prevent the rail trigger placed near the stations from taking up the "line clear" position at the moment when the train is leaving the next station, the lever shown in Fig. 6 cuts off, by means of two contacts moving conjointly therewith, the circuit of the re ease magnet (Fig. 2). The disc magnets can be made to operate with a normally closed circuit, and in this case, if the current fails, the relaxed levers (Fig. 6) cut off the circuits of the release magnet (Fig. 2), thus preventing the signal or the rail trigger standing at "line clear." The displacement of this lever closes a local bell circuit, which thus signals the failure of the current.

Where the trains always run in the same direction on each track of double lines, the discs in the box will be reduced to two only.

In circuit with the rail contact box is a recorder (Fig. 7), comprising a paper roll, driven by clockwork, and over which are placed several magnet pens. These are in circuit with the rail contact devices, and when a train passes one or other of these, the corresponding pen makes an impression on the chart, which is divided into five-minute intervals. As each pen marks the time of a train's passage over a contact device, and as the distance between the successive contact devices is known, the speed at which the train travelled between two contact devices can be calculated, and, further, it is known between which two contact devices the train is to be found if it has stopped from any cause.

In Fig. 8 a diagram of the chief connections is shown for two stations, and having described the different apparatus, it will be interesting to deal now with their practical application with a view to the avoidance of railway accidents commencing with those of the most dangerous class, viz., a collision between two trains running in opposite directions upon the same line. It will be shown, further, that, by the aid of the apparatus described, it is not only impossible for a collision to take place, but even for two trains to be running in opposite directions upon the same line at one and the same time.

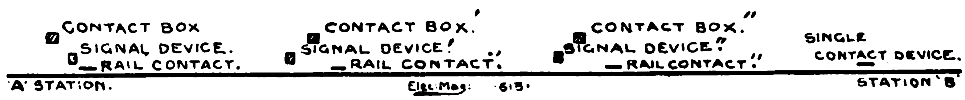


FIG. 10.
ASSEMBLY OF APPARATUS FOR SEVERAL SECTIONS BETWEEN STATIONS.

When the apparatus is first put into use, it must first be seen that the line is free from any trains. Referring to the diagram, the contact box, signal device, and rail contacts for one station are shown on the left, and the corresponding apparatus for another station on the right. That on the left will be called station A, and that on the right station B. To permit of the departure of a train from A, the rail trigger on the signal device must be raised to "line clear," and this is effected by inserting the plugs into the holes

in the contact box and closing thus the circuits through the bi-polar magnet (Fig. 2). The armature at once rotates (contra-clockwise), the semaphore is lowered, and the rail trigger raised clear. In its onward passage the train passes over the rail contacts, and the circuits of the disc magnets in A and B stations are first closed and afterwards opened (when the train passes the second contact) and the discs in the boxes moved to the extent of one hole. The circuit of the release magnet normally closed will also be opened and the rail trigger at station A together with the semaphore-arm will return to "line blocked," to protect the train on its passage through the section towards station B. The holes in the discs of the contact boxes in both A and B stations, in moving forward, by reason of the impulse sent by the passing train, will now not coincide and the plugs previously inserted to release the train from station A can no longer be put in to permit the entrance of another train into the section. The line will therefore be blocked until the train reaches the contact device, some distance from station B. On passing over this contact the disc magnets will again be operated at both stations, and the holes in the discs brought to a position admitting of the insertion of the plugs and the closing of circuits (as before) for the despatch of a train. It must be mentioned here that in each contact box there is a special device fitted to prevent a signal being placed at "line clear" precisely at a moment when a train is passing over the contact device at the departure-station and also to prevent it standing at "line clear" should it have been placed in such a position. This arrangement, shown in Fig. 9, comprises a special insulating mounting of spring contacts, on the end of an armature. These springs rest on contact blocks in circuit with the release magnet, and on the magnet below the armature becoming energised the release magnet circuits are opened when the signal and rail trigger will at once assume "line blocked" position. When two or more trains are needed to run in the same section, following each other, the section is fitted with several rail contacts and signal devices. Fig. 10 represents diagrammatically the arrangement necessary for this. A train leaving station A passes over the first rail contact, closes the line behind it, and signals "line blocked" in the rear. Until the train has passed the second rail contact, a second train cannot be started, and if the first train stops *en route* the signals in its rear will be correspondingly set to protect it. The same cycle of operations will be repeated for the other sections.

The system can be successfully operated without the contact boxes, the trains automatically protecting and signalling themselves while in their sections and when leaving them.

COMO AND PONT ST. MARTIN POWER PLANTS IN NORTHERN ITALY.

By ENRICO BIGNAMI.

THE town of Como, which is proud to have seen the births of the two Plinys and Alexander Volta, was formerly noted above all else for the beauty of its lake. Since then, however, it has become celebrated for it industries, which are extending every day, chiefly on account of the development of important water-power plants.

The most important of these plants is that recently completely by the Società Elettrica Comense A. Volta at Corrido, utilising the water of the torrent Cuccio. This springs from the southern eminences of Pizzo di Geno Menone (7000 ft. above sea level), which enclose the valleys known under the generic name of Val Cavargna, and forming an hydrographical basin of about forty-five mq. above Ponte Dovia. At this point the two principal branches

of the torrent unite, and take the name of Cuccio, flowing into Lake Lugano, near Porlezza. There are two different water entrances for the torrent; one on the east, or Cusino's branch; the other on the west, or San Nazzaro's branch.

The two ducts are formed by weirs, and the entrances are protected by strong iron gratings. The weirs are strengthened by walls of such a height to be suitable for passing the greatest floods. The water is conducted to clearing and store basins. From the clearing basin proceeds the canal which is partly tunnelled and partly in the open, the total length being 2¼ miles. The open portion of the canal has been partially covered with cement flags, and for the most part with chestnut-wood planks. The pipe-line is taken from the summit level reservoir, and consists of two parallel tubes, each having an internal diameter of 23 inches. These pipes are provided at the summit level reservoir with two overflow hand-regulating valves, which are automatically closed in the case of the rupture of a tube. These automatic valves are carefully balanced by counterweights. The double conduit has a total length of 75 yards, of which 45 yards are of cast iron, and 30 yards of steel plate. Both the conduits, at their ends, are connected to a collector tube of steel plate, whose internal diameter tapers from 35 inches to 22½ inches. From this tube five branches of steel pipes are taken having a diameter of 10 inches, one for each waterwheel, and a sixth branch having a diameter of 2¼ inches of cast iron pipe for the exciter waterwheels.

The power station consists of a large machine room 115 feet long by 26 feet wide, and 39 feet high, and of six other rooms for various other purposes. Underground channels are provided for the discharge water and conduits to protect the connecting cables. In the engine room there are seven groups of water turbo-generators. The two small sets, comprising Pelton wheels of 100 and 75 h.p. respectively, are coupled to direct current dynamos, which serve for the excitation of the large alternators; one of the group is kept as a reserve. Each of the other five units, of which one is reserve, has a

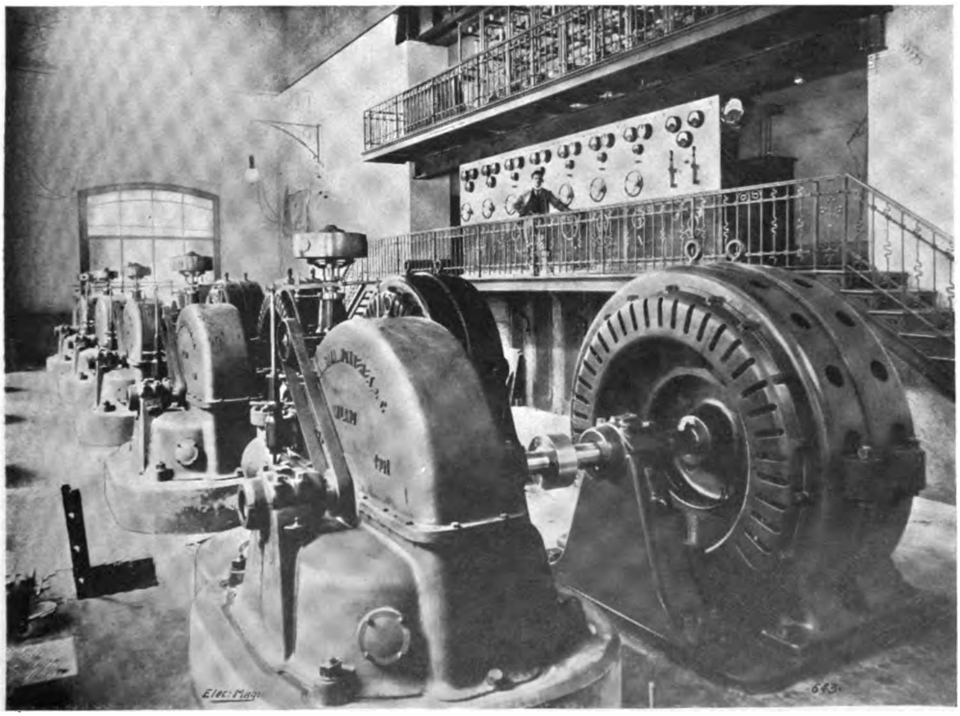


Fig. 1.
Interior Como Power-house, showing Turbo Generators and Switchboard.

Fig. 2.
View of Power Line, showing Country traversed.

capacity of 650 h.p., and is coupled to the horizontal shaft of a Pelton wheel.

The three-phase alternating current inductor alternators generate current under a pressure of 4000 volts, 42 periods. By means of oil-cooled transformers, with water circulation, this pressure is raised to 20,000 volts, at which it supplies the transmission lines. The connections between the machines, the switchgear, and the lines, and also the distribution of the switchboards, have been carefully studied with a view to obtaining the greatest possible simplicity in working. In addition the particular needs of the plant were considered at the same time. Each alternator is connected to its corresponding transformer, no connection existing between the 4000 volt conductors of the several groups. The 20,000 volt conductors of each transformer terminate in omnibus bars, and on each line are mounted three-poles circuit breakers. Paralleling is performed by closing the high tension switches. The whole of the electrical plant was manufactured and executed by the Società Italiana di Elettricità Brown Boveri.

The energy from the power house is transmitted—by bare copper overhead conductors, fixed to insulators, and supported by wooden poles (among such is a small number of iron poles)—to Menaggio and to the town of Como, touching some of the surrounding localities, for industrial and lighting purposes.

The transmission line is made up of two circuits, both being generally in service, but one is equal to the whole output without serious loss. There are two receiving and transforming stations; at Piazza San Stefano, and at Como. The former contains at present two oil transformators, with natural cooling, of a capacity of 200 k.w.; the second is equipped with two single 630 k.w. oil transformers, but provided with water circulation. These two stations reduce the line tension from 20,000 to 3600 volts; from the first station the secondary conductors end at Cernobbio, Maslianico and Ponte Chiasso, and from the second the whole network of the town of Como and neighbouring locality of Camerlata is supplied.

Fig. 3.
Bank of Oil-cooled Transformers.

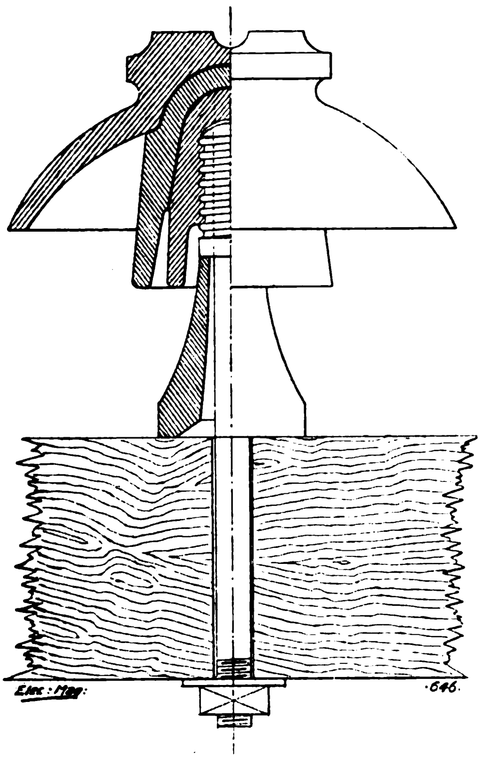


FIG. 4.
SECTION OF THREE-PART INSULATOR USED ON THE LINE.

The station of Corrido can supply for the greater part of the year from an available fall which produces about 3500 h.p. The Società Comense Alessandro Volta delivers energy in bulk and by meter for electric power purposes, but does not concern itself directly with the private and public lighting, on the grounds of general expense. The municipality at Como looks after the lighting, and in the other localities there are several private firms with special contracts. The average price per k.w. per annum is 300*l.* (£12), and 40 cents and 15 cents per k.w.h. measured by meter.

In a few cases the energy is delivered at 3600 volts, the consumer in this instance being responsible for further transformation.

From the Lake of Como we will turn to the description of another power plant situated in one of the most charming of Italian valleys—the Val d'Aosta. Formerly the mining industry flourished there and the whole stretch of land is exceptionally rich in ore. The development of the industry was no doubt due to the abundance of water from the large river crossing the valley, and the numerous watercourses which empty themselves into the former. The most important of these is the Dora Baltea, having a length of 100 miles, 62 miles of which traverse the Val d'Aosta, which terminates at Pont Saint Martin.

When hydro-electric installations became commercially possible, the Dora Baltea and its tributaries were carefully studied. Quite a number of schemes were projected, but few were actually developed owing to the great distance separating the generating and utilising centres, and also to the protracted periods of shallow water, which reduces to a tenth part the value of the smallest flow of these watercourses. For this reason it was not thought desirable to instal plant for transmission over long distances. The plant constructed by the Industrial Electrochemical Society of Pont Saint Martin was originally designed to utilise energy on the spot, but in course of time, seeing that the power available reached 56,000 h.p., the Society decided to construct a plant which could utilise the whole energy. The greater part of this is transmitted to the regions of the Biellese and the Canavese for industrial purposes, and the remainder,

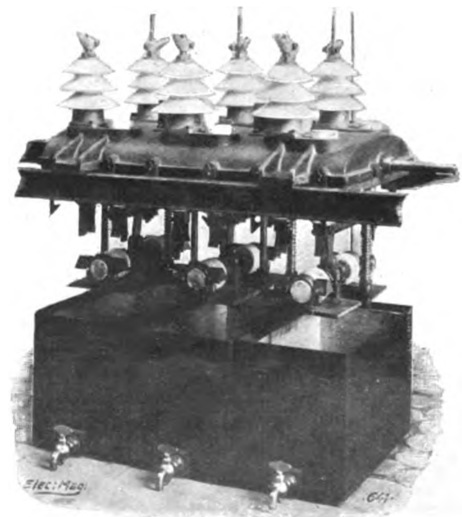


FIG. 5.
E. H. T. OIL BREAK SWITCH.

which is liable to interruptions, directly for electro-chemical purposes.

The water intake for this installation is on the left side of the Dora Baltea, almost opposite the Station of Pont Saint Martin, where a dam 6 feet high, 29 feet long, 20 square yards area, has been constructed. It is built of concrete and arranged not only to direct the water towards the mouth of the canal, but also to raise the level. The mouth of the canal is obliquely arranged to the flow of water. It is 49 feet wide, and is furnished with two clearing basins, for the deposition of the gravels and sand. The canal has a length of 870 yards, of which 450 yards are tunnelled, and the remainder is open to the sky.

A few feet beyond the entrance there is the first overflow of 328 feet length designed for discharging the excess water into the Dora. A second overflow of the same length is situated in the neighbourhood of the power house. To avoid disturbances near the waterwheels, the water from the second overflow descends through a range of wells and pipes, which do not end directly in the overflow canal, but in a lateral basin.

The waterwheels were constructed, as are those for the plant of Como, by the A. Riva, Monneret and Co. of Milan, and the dynamos and transformers by the firm formerly Schuckert and Co. of Nürnberg. The roofing and the two bridge cranes, of a portable capacity of fifteen tons and ten tons respectively, were furnished by the Society Officine di Savigliano of Turin. The large waterwheels are of the "Francis" type with two wheels coupled on the same shaft. The shaft passes through the wall of the building and is directly connected with the alternators. To obtain a high efficiency and high speed, the waterwheels were constructed for a larger diameter at the discharge point than at the delivery. The small waterwheels for the exciters are of "American" construction. There are four three-phase dynamos of the revolving inductor type, generating current at 3000 volts between the wires. This current is taken to the switchboard.

FIG. 6.
EXTERIOR OF COMO POWER-HOUSE.
(The pipe-line is not visible.)

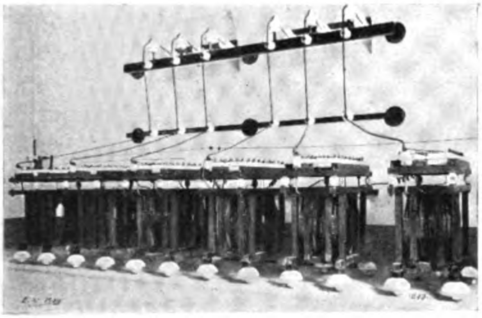


FIG. 7.
AIR-COOLED TRANSFORMERS AND CONNECTIONS.

where there are, for each machine, breakers, fuses, and instruments. Bus bars are provided, from which the conductors are led to the transformers for raising the pressure from 3000 to 15,000 volts. All the switchboards are situated in the engine room and placed on the same floor.

There are twelve transformers, each of 300 k.w. They are of the oil-insulated type with corrugated cases to facilitate cooling.

The 15,000 volt current is conducted to three bus bars, whence six wires leave the station through a metallic tower which also serves as an anchorage for the external lines. Two lines lead towards Biella, crossing the commons of Sala, Mongrando, Occhieppo, a total distance of eighteen miles. From Borgofranco and Biella there are branches towards the Canavese, on one side, and Val d'Andorno and Valle Mosso on the other side, as far as Pianceri (Val Sessera), a distance of fifty-four miles.

The maximum energy which can be placed at the disposal of customers is 2300 h.p. There are at present sixty-five customers, who are for the most served by transformers and motors made by Gadda and Co. of Milan. During the winter, 1000 h.p. is furnished to the electro-chemical works where barium hydrate has until recently been manufactured. At present, however, calcium carbide is the chief product, the plant for that purpose being illustrated among the other views of the installations described in the above article.

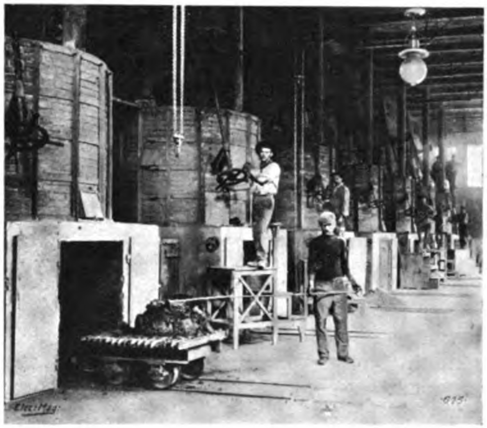


FIG. 8.
CALCIUM CARBIDE WORKS, PONT ST MARTIN.

ON SUPERHEATED STEAM FOR STEAM-ENGINES AND TURBINES.

By ARNOLD H. GIBSON, B.Sc.

ALTHOUGH the use of superheated steam in the cylinders of a reciprocating engine is now a matter of ancient history—so far as the history of the steam-engine goes—and although of late years such strides have been made in the installation of superheating plant, especially for use with the steam turbine, yet the vague ideas and theories still occasionally put forward in the technical press, to account for the economy due to its use, render an apology unnecessary for again taking up the subject.

And firstly it would be well to get a clear idea as to precisely what is meant by the term superheated steam, as

opposed to saturated or to wet steam, and as to the physical properties of these different classes of steam; also as to how they respectively behave under given circumstances.

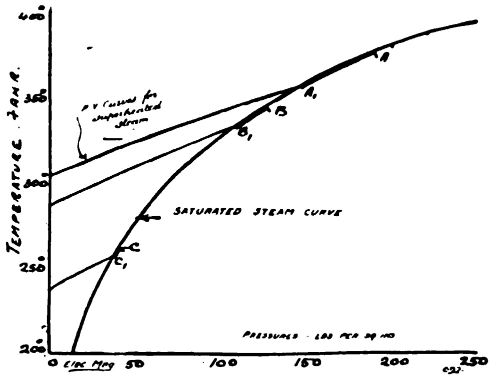
Firstly, steam in contact with the water from which it is generated, will generally be found to contain a certain percentage of moisture in the form of suspended particles of water. This steam is called wet steam, the rates of the amount of dry steam, to the amount of the mixture, being known as the dryness fraction.

If this steam be led away from the generating vessel, the entrained particles of moisture will be removed from suspension by gravity, and the steam thus obtained is called dry saturated steam.

This is the steam, the properties of which were determined by Reynault in his series of classic experiments. If now dry saturated steam be heated, either at constant volume, or, as is commonly the case, at constant pressure, by being passed through a series of highly heated tubes, to a temperature above that at which it is generated, we get a substance approximating in its properties more nearly to a perfect gas than does saturated steam, and this substance we call steam gas, or more commonly superheated steam. Finally, if steam gas be sufficiently heated it is decomposed into its element hydrogen and oxygen. The temperature at which this takes place is, however, quite outside the limit within which working with superheated steam is practicable.

Dr. J. H. Grindley, in a series of experiments, the results of which were communicated to the Royal Society in 1900, investigated the condition of superheated steam by wire-drawing saturated steam which had been mechanically drained of entrapped water, by passing it through a small orifice, and measuring the temperature and pressure of the steam before or after passing through the orifice. Adiabatic expansion took place in the orifice and the work thus done on the steam by neighbouring particles of steam was turned into velocity energy. On the steam coming to rest, this velocity energy was again turned into heat energy, which being given to the steam—now at a lower pressure—superheated it to a temperature higher than that corresponding to the temperature of saturated steam at the reduced pressure.

Provision was made for altering the pressure on both sides of the orifice, and a few of the results he obtained, are roughly indicated in the accompanying figure. From the figure we see that as the temperature of the steam is reduced by wire-drawing, the curve connecting pressures and temperatures, follows the saturated steam curve for some way, the steam behaving exactly as if it still contained some water in suspension. Thus at 238° F. dry saturated steam behaves exactly as if it had a dryness fraction of .9991, and at 370° F. as if it had a dryness fraction



of .9639. From this it follows that what is usually called dry saturated steam is not steam gas. This also accounts for the fact that when dry saturated steam is superheated, the increase in volume for small degrees of superheat, is considerably more than would be expected in the case of a perfect gas.

As the temperature and pressure are still further reduced by wire-drawing, the curve becomes very nearly a straight line, approximating somewhat to that of a perfect gas.

If these curves be produced to cut any constant pressure line, the intercept made by any two of the lines on the constant pressure line will equal $T_1 - T_2$, and if H_1 and H_2 be the total heats of evaporation of saturated steam, which when freely expanded adiabatically to pressure "p," will be at temperature T_1 and T_2, the specific heat of the steam gas, and the constant pressure "p," between these temperatures is $\frac{H_1 - H_2}{T_1 - T_2}$

H_1 and H_2 may be obtained from

Reynault's tables. Now if superheated steam ever does become very nearly a perfect gas, this will be at temperatures far removed from the temperature of saturation, that is when the pressure is small. Producing the curves therefore, till they intercept the line of zero pressure, the values of the specific heat deduced by taking the temperatures given by the intersection of these curves with the zero pressure line, show a continual increase of specific heat with the temperature, and also that the specific heat is approximately independent of the pressure. Since in a perfect gas, the specific heat does not vary with temperature, the experiments show that even at very low pressures, steam does not become even approximately a perfect gas.

The following table gives values of the specific heat calculated in this way:

Pressure (abs.) lbs. per square inch.	Temperature between which specific heat is taken.	Specific heat.
5	224° Fahr. — 240° Fahr.	.4211
	255° ,, — 264° ,,	.4984
10	227° ,, — 243° ,,	.4263
	258° ,, — 267° ,,	.5039
14.7	231° ,, — 246° ,,	.4317
	295° ,, — 311° ,,	.6482
20	234° ,, — 249° ,,	.4488
	297° ,, — 313° ,,	.6522
30	255° ,, — 269° ,,	.4778
	301° ,, — 318° ,,	.6443
50	288° ,, — 310° ,,	.6238
	310° ,, — 327° ,,	.6292
70	319° ,, — 336° ,,	.6329
85	325° ,, — 342° ,,	.6602

In a series of experiments carried out by Hire's value of the specific heat of superheating steam between the temperatures 240° F. and 316° F., values ranging from .305 at the lowest temperature to .931 at the highest temperature were obtained.

A series of experiments at present being carried out at the National Physical Laboratory will probably throw much needed light on the correct values to be adopted for this specific heat.

Experiments recently carried out by Lorenz give values of the specific heat varying from 0.48 at low pressures to 0.62 at high pressures and temperatures.

Next to compare the behaviour of saturated and superheated steam when used expansively in an engine cylinder, or in a steam turbine.

In every case, the work done during expansion by the steam, must of necessity be done at the expense of a portion of the heat contained in the steam, and as saturated steam is liquefied on parting with any of its heat, it follows that with dry saturated steam, liquefaction will take place, the latent heat thus set free, being used up, partly in doing mechanical work, and partly in keeping the remainder of the steam in a state of saturation. If, however, the steam be initially accompanied by water in suspension, an expansion taking place, a portion of the water may be also evaporated, depending on the proportion of water and steam originally present. In any case, with saturated steam, a considerable amount of water will be deposited in the engine or turbine cylinder.

If superheated steam be expanded adiabatically, and to do work, as before the steam must lose heat in doing this work, but now the steam can part with a considerable amount of heat—that given to it while being superheated—before its temperature falls to that corresponding to saturation, that is without any liquefaction taking place.

If more work is now done by the steam, liquefaction must of course take place. So, although, on account of the fact that the materials of which our steam-engine cylinders and our turbines are made, are good conductors of heat, adiabatic expansion is practically impossible—except in one particular case—yet we see that with any expansion approximately following this law, considerably more moisture will be present in the cylinder using saturated steam than in one using superheated steam.

The particular case referred to is that of a steam turbine of the de Laval or diverging nozzle type. Here, expansion takes place entirely in the nozzles, and with such rapidity that the heat conducted from the small surface of the nozzle to the steam is negligible.

Again, if a volume V, of steam, saturated or superheated, expand from a pressure P, to a volume V_2, in an engine cylinder or turbine, following a law PV^n = con-

stant, the work done during admission and expansion will be $\frac{P_1 V_1 (1 - r^{1-n})}{n - 1}$ where r is the ratio of expansion $\frac{V_2}{V_1}$. P_1 is the pressure in lbs. per square foot, and the result is in foot lbs.

The examination of a large number of diagrams taken from modern engines with valves and pistons which were presumably tight, shows that the value of n, when saturated steam is being used, varies from .835 to 1.14, an average value of the large number of valves taken being 1.013.

The value of n for superheated steam is generally taken to be 1.3.

So that with equal volumes of superheated and saturated steam at the same pressure, and expanding to the same volume, the ratio of the works done will be $\frac{1 - r^{-\cdot 013}}{\cdot 013} \times \frac{\cdot 3}{1 - r}$; (neglecting back pressure),

If $r = 3$ the ratio is 1.133
If $r = 4$ the ratio is 1.195
If $r = 5$ the ratio is 1.235

the greater amount of work per cubic foot being performed by the saturated steam.

But if the temperature of saturated steam at pressure P_1 is $T_1°$ (abs.) and if $t°$ be the amount by which the steam is superheated, then steam which initially occupied a volume V_1 will now occupy a volume $V_1 \times \frac{T_1 + t}{T_1}$.

So that if the degree of superheat be, say 120° F., the ratio of volumes of equal weights of saturated steam will be :

At 20 lbs. per sq. in. abs. press	. .	1.173
At 50 lbs. ,, ,, ,, ,, ,,	. .	1.162
At 100 lbs. ,, ,, ,, ,, ,,	. .	1.151
At 125 lbs. ,, ,, ,, ,, ,,	. .	1.148
At 150 lbs. ,, ,, ,, ,, ,,	. .	1.145

Hence we get the following results :

Ratio of expansion.	Pressure lbs. per square inch.	Ratio of work done per cubic foot of saturated and superheated steam.	Ratio of work done per lb. of saturated and of superheated steam.
3	20	1.133	$\frac{1.133}{1.173} = .966$
3	50	1.133	$\frac{1.133}{1.162} = .976$
3	100	1.133	$\frac{1.133}{1.151} = .984$
3	150	1.133	$\frac{1.133}{1.145} = .989$

But if H be the total heat of saturated steam at any particular pressure, and if k be the specific heat of superheated steam between the temperatures of superheat, the ratio of the heats given per lb. to the saturated and to the superheated steam will be $\frac{H}{H + kt}$. So that finally the ratio of this ratio, to that of the work done per lb., will give the thermodynamic efficiency of the superheated, relatively to the saturated steam. These efficiencies work out as follows :

Ratio of expansion.	Pressure lbs. per sq. inch.	Work done per lb. of saturated steam. / Work per lb. of superheated steam.	Heat per lb. of saturated steam. / Heat per lb. of superheated steam.	Efficiency of superheated steam.
3	20	.966	.956	.989
3	50	.976	.949	.974
3	100	.984	.944	.960
3	150	.989	.942	.953
4	20	1.018	.956	.938
4	50	1.027	.949	.926
4	100	1.037	.944	.912
4	150	1.044	.942	.904
5	20	1.053	.956	.907
5	50	1.062	.949	.893
5	100	1.072	.944	.881
5	150	1.078	.942	.874

We see from this that from this standpoint, the efficiency of superheated steam is less than that of saturated steam, and that with a given degree of superheat, the efficiency becomes less, the higher the pressure and the greater the ratio expansion used. Evidently then, the efficiency which is actually obtained by the use of superheated steam in practice, must be looked for in some other direction. But as we have seen, by using superheated steam liquefaction is wholly or partly prevented, and it is to this that the efficiency obtained is due. In the steam-engine, it is now generally understood that if in any way liquefaction can be prevented, the bad effects of initial condensation are nullified, and there is much less heat wasted by rejection to the condenser. The experiments of Messrs. Callender and Nicholson also show that considerably less leakage is to be expected

past the valves of any engine using superheated steam.

In the case of the steam turbine, dryness of the working steam tends to economy in various other ways. In the first place there is, in turbines of the Parson's type, an extremely small amount of clearance between successive rows of moving blades, and of fixed vanes, and should a film of water be deposited between such surfaces, the viscous frictional resistance thus caused will be very great. Again, it has been experimentally proved, that the resistance to rotation of a turbine disc, caused by the viscosity of the medium in which it rotates, is proportional to the density of the medium, and hence is much less with superheated steam, than with dry saturated or wet steam.

In another way too, the presence of moisture in the steam will tend to losses in working, since the presence of particles of water, which have a relatively small velocity, in a jet of steam moving with very high velocity, will reduce the velocity of the jet, below that calculated; will cause eddies to be formed in the steam, and will thus reduce the efficiency of the turbine.

From these considerations, it is evident that the degree of superheat should be as high as possible so as to keep the steam dry, during its entire passage through the machine—engine or turbine—or at least as far as possible, and if enough heat could be given to the steam in the form of superheat, to allow of the whole work done per lb. of steam, being done at the expense of this superheat alone, there would be no liquefaction. When the degree of superheat was just great enough for this to take place, we should be getting the maximum possible advantage out of superheating.

But unfortunately, this is impossible in practice, since the temperature of the steam would then be so great that the metals of construction would be excessively weakened, and in addition no lubricating oils could be obtained which would stand the temperature. For example, the necesssary temperature of superheat to fulfil the required conditions, in a turbine or steam-engine using steam between the pressures 165 lbs. and 1 lb. absolute, would be approximately 1000° F.

So that all that can be done is to use as high a degree of superheat as the materials of construction will stand, and as the difficulties due to increased expansion of working parts and to increased difficulties of lubrication will admit.

In the case of a turbine of the de Laval type, however, in which the steam expands adiabatically in a diverging nozzle before entering the turbine proper, since the temperature of the steam falls during this expansion, any degree of superheat which the superheater is capable of standing, will be advantageous.

Also in this case there is no difficulty due to unequal expansion, or to difficulty of lubrication; indeed, this last difficulty vanishes in the case of all turbines, running as they do, without any oil in the working chamber.

In a central station plant. driving a tramways load, the fluctuation of the demand for power is very great, and if Corliss valve engine be used, governing by adjustment of the point of cut-off, the cut-off will at times come very early in the stroke. This gives rise to large fluctuations of temperature in the cylinder steam, and hence exaggerates all the evil effects—initial condensation, &c., which are thus caused. In this case, for economical steam consumption, superheating, or steam-jacketing is quite essential.

Next as to the type of superheater to be used. Superheaters may be divided into two large classes—those which form part of the boiler itself, and which are heated by the gases from the boiler furnace on their way to the chimney, and those which are separately fired, having a setting quite apart from that of the boiler.

Each type has its own advantages and disadvantages. The first type, needing no separate setting, is in general cheaper and takes up less room than the second. On the other hand, an accident to the superheater may mean shutting down its accompanying boiler completely, while with the separately fired superheater, should any accident occur, or should new tubes be required, the superheater can simply be cut out of the ring for the time being.

The temperature of the steam can be more accurately regulated in the case of the separately fired superheater, and this is particularly important in the case of a

plant driving a fluctuating load—say tramways, where the demand for steam varies considerably, and where consequently the rate of flow of steam through the superheater tubes also varies considerably. So that at light loads, the steam, remaining longer in contact with the heated tube surfaces, will receive a much greater degree of superheat than at heavy loads, and in some cases the degree of heat may be sufficient to damage the tube.

Arrangements should be made so that the superheated tubes may be cut off from the action of the hot gases while steam is being raised, or while the boiler is standing, in preference to flooding the tubes, the latter having a destructive action on the metal, and causing the tubes to scale badly.

In a superheater forming part of the boiler, and installed in the boiler setting, the tubes should be placed so that they are in contact with the hottest part of the flue gases.

The practice of installing the superheater tubes in the flues, so that the gases pass over them just before escaping to the chimney, is not to be recommended, as the temperature gradient between the two sides of the tube surfaces is then only small, and although the heat thus given to the steam would otherwise be entirely wasted, yet the small amount of superheat obtained with a moderate amount of tube surface would generally be insufficient to compensate for the cost of the superheater, and for the cost of maintenance.

In conclusion—superheating tends to increased efficiency in any plant using reciprocating engines or turbines, and the older and more wasteful the machines are, the greater will be the advantage resulting from superheating. The efficiency is not due to thermodynamic reasons, so much as to the prevention of losses by initial condensation, &c., in the case of a reciprocating engine, and by viscous frictional resistance in the case of a steam turbine. Generally speaking, a reciprocating engine plant will gain more from superheating than will a turbine plant, and a slow-speed engine plant more than a high-speed plant, other things being equal. The superheater is the salvation of the badly designed station and an effective superheater covers a multitude of sins in unnecessarily long steam-pipe ranges—boilers which prime—and cylinders which are badly drained and lagged.

Arnold. H. Gibson

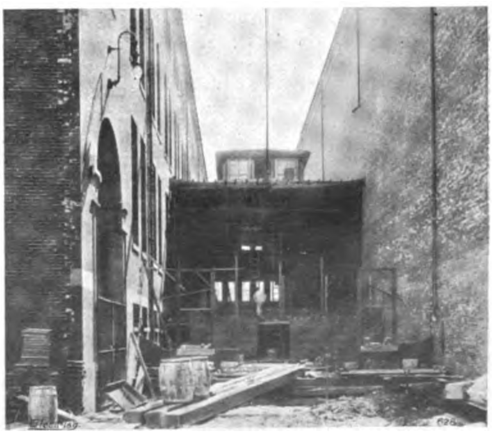
Readers are referred to the World's Electrical Literature Section at the end of the Magazine for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

The Boston Edison Illuminating Company's Plant.

By W. E. WARRILOW, A.M.I.E.E.

LIKE many old American stations, the plant of the Boston Edison Illuminating Company has passed through many extraordinary phases. A glance at the development of this undertaking shows how rapid have been the changes in the design of electrical machinery in the space of twenty years. At the outset, much capital was necessarily expended in the installation of units which by the side of present-day designs are as comparable as turbine and reciprocating engine. With an extremely rapid demand, such units had to be installed in quick succession, with the result that the extensions made to about the middle of 1891 totalled 3,840 k.w., and were spread over some sixty-four dynamos and thirty-two engines, it being the practice in those days to drive two dynamos from one engine for operating on the three-wire system. In 1892 a total capacity of 5,540 k.w. was reached by the addition of eight dynamos, coupled direct to slow-speed triple-expansion engines, the dynamos being placed at each end of the engine-shaft. This capacity saw the company through until the middle of 1896, when an additional 1,200-h.p. engine with two 400-k.w. dynamos coupled to the engine as before was installed, thus bringing the total capacity of the three stations then erected to 6,240 k.w. In 1899, practice being again changed, two vertical engines of 1,200 h.p. capacity were installed, direct-coupled to 800-k.w. machines, intended for use across the outers of the system only. In 1901 a cross compound engine, with dynamo between the cylinders, was in favour, and four such units of 1,600 k.w. capacity each were installed. At this time the purchase of the L Street Station of the Boston Electric Light Company was completed, and it is with the turbine plant to be installed at the new portion of this station that we are concerned.

The old portion of the station, which was built in 1898, contains six vertical cross compound engines, each of 2,350 h.p., driving a 1,500-k.w. 2,250-volt three-phase, sixty-cycle alternator, delivering energy to the distributing system in Boston, this station, with the plant installed at the third station above-mentioned, bringing the total capacity of the Boston Edison system at the present time to 19,400 k.w. This figure takes no account of the old bi-polar machines installed in the first and second stations. When the two 5,000-k.w.



BOSTON POWER PLANT, SWITCH HOUSE.

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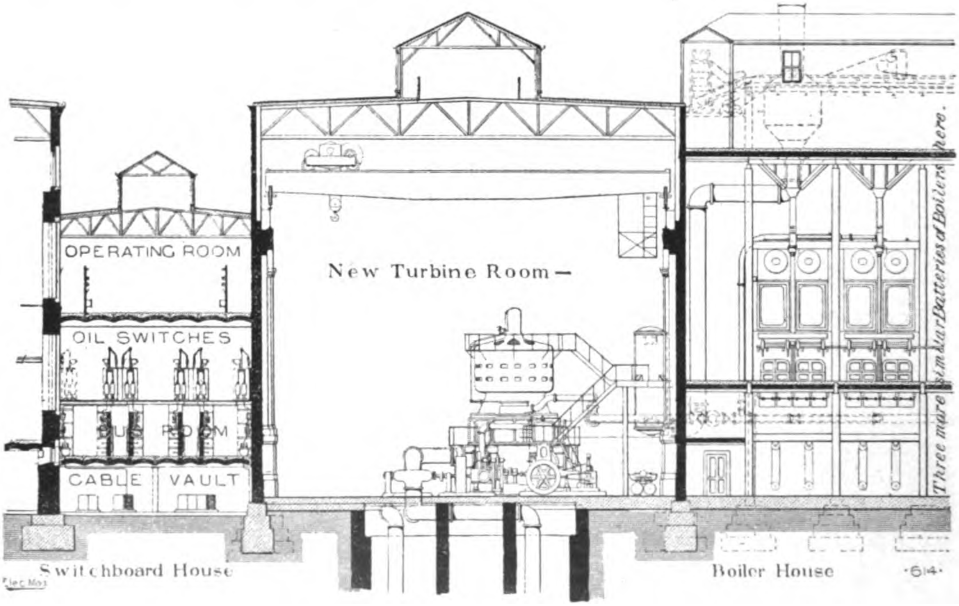
turbine sets to which we shall refer later are installed at the new L Street Station, the entire capacity of active generating plant at that station and Atlantic Avenue (the third station) will be nearly 30,000 k.w. It will thus be seen that between 1886 and the present time the company has installed representative types of electrical apparatus, and increased their capacity from 25 k.w. to that above-mentioned by the increase of connected loads and purchase of other light systems, and the transmission of energy to towns and cities in some cases more than twenty-five miles distant. About sixteen months after the first plant was in operation 8,500 incandescents, representing 200 consumers, and about 80 motors, were being supplied. By the middle of 1901, before the purchase of the Boston Electric Light system, the number of lamps connected included 2,500 arcs, 247,935 incandescents, and 1849 motors, with an aggregate capacity of 5,408 h.p. Since the purchase of the latter company, and including the twenty-five-mile area supplied outside Boston, together with the growth of business in that city, the Edison Company has coupled up to its lines a load representing 681,162 incandescents, 9,803 arcs, and 24,225 h.p. in motors, the total load representing an equipment of 1,152,379 incandescents of 16 c.p. each.

The accompanying illustrations will give some idea of the arrangement of the new L Street Station, and speak more than words for the extraordinary rapidity with which steam dynamo-electric machinery has been simplified and almost perfected. The history of the plant above referred to tells a most eloquent tale of the improvements effected in power-house designs. We are able to reproduce a few illustrations of this plant through the courtesy of our contemporary, *The Electrical Review* of New York, which has kindly furnished drawings and photographs.



SECTION OF BOSTON EDISON ELECTRIC COMPANY'S NEW POWER HOUSE.

The station is divided into boiler, turbine, and switch houses by heavy brick walls, running parallel with the greater dimensions of the building. The boiler house has floor dimensions of about 146 ft. by 630 ft. The space available for switching apparatus measures 28 ft. by 562 ft. The turbine room is between the switch and boiler houses, and is about 65 ft. wide by 642 ft. long. It is designed to contain twelve 5,000-k.w. turbo-generators, arranged in a single row from end to end of the room, with about 11 ft. from the wall between the turbine and boiler houses. In line with each unit, but on the other side of the wall, is a row of eight 500-h.p. boilers for supplying steam to each turbine, or 4,000 h.p. to the group. These batteries and boilers, of which there are ultimately to be twelve, run in parallel rows across the shorter dimension of the boiler house, and the rows are arranged in six pairs, back to back, with a chimney between them for common use. Beneath the boiler room is a basement, forming a chamber for receiving the ashes from the grates above. Beneath each chamber, arrangements are made for dropping out the ashes on to a cart or conveyer. The steam and water mains for the boilers are also

located in this basement. Above the front of each row of boilers there is a coal-conveyer and steel-bunker, from which coal gravitates to the mechanical stokers in front of the boilers. Beneath the floor of the turbine room are three sluice-ways for carrying sea-water to and from the turbines for condensing. Two of these are equal in size, and carry the cold sea-water to six turbines. The third is larger, and returns the heated water from the entire row of turbines to the harbour. Each turbo unit has its centrifugal pump for condensing water, a boiler feed pump, an oil feed pump for the turbine step-bearing, an accumulator storing oil under pressure for the same bearing, a separator between condenser and dry-air pump to prevent the passage of water to the latter, and a feed water-heater and hot well for the storage of water. All this apparatus is steam driven. There are other conduits beneath the floor for the reception of connecting cables, which pass to the basement and the switch house, whence they are conducted to motor-operated oil switches on the second floor, the same switches completing the connections with the four sets of bus-bars on the first floor. On the latter floor are also knife switches for opening lines not in use, lightning arresters, and instrument transformers. The main operating room is on the third floor of the switch house, and from this a door leads to the observation gallery projecting into the new turbine house. Access is also given to the old station.

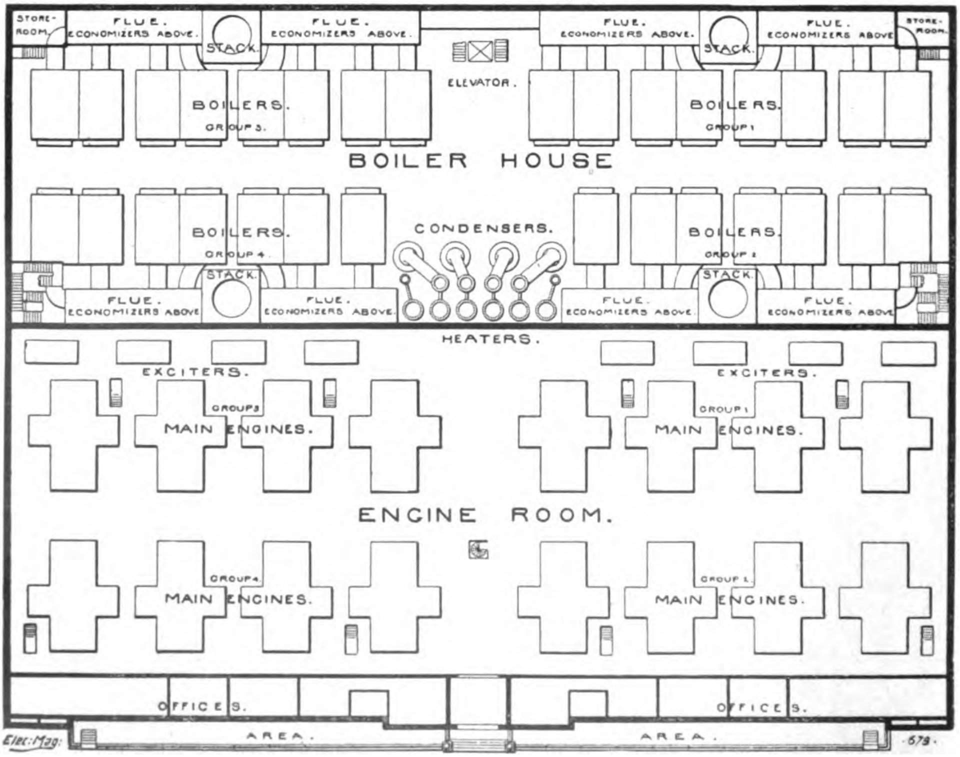
The company has a coal wharf extending into the dock a distance of 368 ft., and on this two coal-derricks are in operation. A third derrick will shortly be added. A 36" belt conveyer runs almost the entire length of the wharf into a coal-pocket on the opposite side of the switch house. This conveyer has a capacity of 700 tons of coal per hour, and feeds a Hunt conveyer distributing the coal in the pocket. At the front end of the latter is a crusher, reducing the coal to 4" cubes. Adjoining the coal-pocket near the old station is a coal-storage, approximately 288 ft. by 516 ft., and special provision is made for distributnig the coal over this large open area, a Brown travelling-bridge being used in conjunction with a number of belts.

The boilers in the new station are of the Babcock Wilcox water-tube type, each with 152 tubes, and operating at 175 lbs. with 150 degrees super-heat. No economisers are used, but the fuel gases from each group of boilers pass directly to the chimney through a short iron flue of 8 ft. by 20 ft. cross-section. The turbines are of the Curtis vertical type of 5,000 k.w. capacity each, weighing 260 tons, and standing about 30 ft. above the floor. The generator, of the General Electric make, weighs 82 tons, of which the armature weighs 42 tons. It has fourteen poles, and operates at 514 r.p.m. and delivers three-phase sixty-cycle current at 6,900 volts, the armature being star-connected. Some 28 k.w., or ·56 of 1 per cent. of the rated armature output, is required for excitation. This current is furnished at 125 volts from the old station. At present only two turbo-generators will be installed with two rows of boilers, sixteen in all, connected to a single dynamo. The power thus derived from two single units is just double that obtained from the six generators in the old station.

COAL CONVEYING BELT, BOSTON COMPANY'S POWER PLANT.

A LARGE RAILWAY POWER HOUSE.

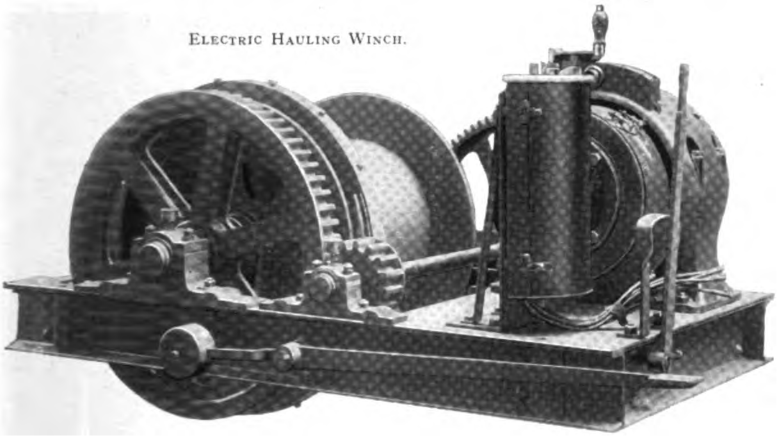
Early in 1898 the Third Avenue Railway Company, New York, designed a large power house for the operation of its electric railway system, at Kingsbridge. It was to contain sixteen 3,000 k.w. units to supply current to 25–1,000 k.w. rotaries in various substations. At the outset half this amount was decided upon and between that date and the present has been installed and put into operation. The station is the outcome of much experience in New York with similar plant, there being a number of almost identical plants in that city. The entire contract for the first half was entrusted to the Westinghouse Co. who made themselves responsible for the electrical section, while Westinghouse, Church, Kerr, were subcontractors for the buildings and steam plant, including engines, boilers and condensers. Delay in completing the plant was due to the financial position of the first company, but on the concern becoming the property of the Metropolitan Street Railway Co., operations proceeded apace. The chief features of the plant are: large cross compound Corliss engines, central barometric condensing plant for entire equipment, steam-driven auxiliaries, air-break switches operated pneumatically. The plant has been arranged to operate in sections of four units each, there being boilers, engines, and switchgear for these sections which can however be coupled together. A glance at the accompanying plan will make this quite clear, the disposition of the various sections being plainly emphasised. The boilers are arranged in two tiers of two rows parallel to the engine room, with coal pocket above and steam piping below the two sets of boilers. The boilers are watertube with mechanical stokers, and work in conjunction with economisers. The engines are 46 in. by 86 in. by 60 in. Corliss with generators between cylinders. The alternators develop 3,000 k.w. each, at 6,600 volts 3-phase 25 cycles, and are fitted with laminated revolving fields. Condensers are barometric jet, four being installed and connected by 54-in. pipes to the engines. Each is capable of dealing with 25,000 h.p. and arrangements are made to start the engines condensing or non-condensing. The switch-gear is in the engine room and overlooks the plant. It is operated by compressed air furnished by a small electric compressor, and the bus bars are arranged for sectioning, there being no duplicate bars.



Plan of Kingsbridge Power House.

HAULING BY ELECTRICITY.

The recent Colliery Exhibition, to which we referred in our last issue, drew special attention to the value of electric power in mines. We referred then to the almost general employment of motors



Electric Hauling Winch.

for driving hauling gears, and to the attention which electrical engineers have given to this type of apparatus. The accompanying illustration depicts a new form of electric winch recently introduced by the British Thomson Houston Co. The controller, motor, and gearing will be plainly seen, and the compactness of the arrangement is at once noticeable. The motor is of the enclosed type, developing 6 h.p. and is suitable through the medium of the winch for hauling load tracks of about twelve tons capacity at a speed of three miles per hour on a level track. The motor is mounted on an extension of the winch bed-plate, and is of the B. T. H. Co.'s standard c.c. type. It runs at 780 r.p.m., and at full load the temperature rise does not exceed 90 degrees Fahrenheit above the surrounding atmosphere. Its normal rating of 5 h.p. can be exceeded to the extent of an additional h.p. for periods of half an hour, and momentarily it will furnish 9 h.p. without undue heating. It operates on a 110 volt circuit, and is compound wound. The winch comprises a rope drum, 2 ft. in diameter by 2 ft. wide, the body being of steel plate, and the flanges of cast iron. An all round brake with clutch-gear is fitted at one end of the drum, the brake lever extending back to the controller, where it is immediately under the foot of the operator. Winches of this type are being supplied to the South Wales Electric Power Distribution Company, and we should anticipate a wide field for such apparatus in any colliery district. Readers will find a description of the South Wales Power Plant in our last issue, page 30.

ELECTRIC POWER AND IRRIGATION.

In a short note last month we referred to the Bear River Power Plant and Utah transmission systems, promising some additional particulars this month. We then referred to the use made in America of the surplus water of irrigation systems where two canals running on opposite sides of a valley on different levels were connected by a syphon pipe, and a generating plant installed at the lower point of the latter. With the rapid growth of Salt Lake City in recent years, a greater demand has arisen than the Utah Light and Railway Company can supply. This company was glad to avail itself of the offer of the Utah Sugar Company, which controlled most of the canals in the district, for the purchase of current from its new station. The utilisation of water power from the irrigation system does not lessen the quantity available, as only the surplus water is used. The canals below the Bear River Canyon can carry the entire flow of the river only during the period of extreme low water, lasting but a few weeks in August and September. The remainder of the year there is more water than is needed for irrigation, and the shutting down of the plant during the few summer weeks does not interfere with the Salt Lake City system, as lighting and power loads are at a minimum at that season. In Fig. 1 a section is shown through the arrangement of the canals and the inverted syphon connecting the two. This has an inside

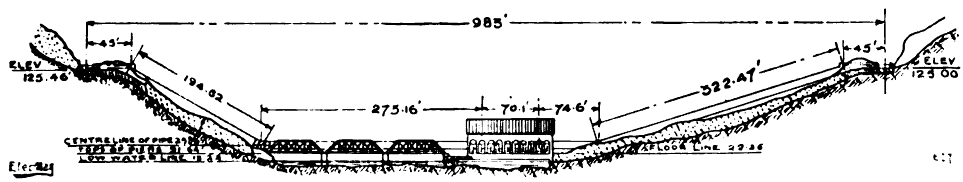


Fig. 1. Section through Bear River Power Plant. Syphon and Canals.

diameter of 8 ft., and a concrete turn-out is provided at each canal, carefully designed to prevent loss of head through water eddies, an iron screen and a large wooden gate for controlling the supply being also placed at each intake. Specially constructed steel-riveted elbows are placed at the lower ends of the pipes, and securely anchored to converter piers. Between these elbows is 418 ft. of straight pipe, the western portion crossing the river on a 225-ft. steel t ree-span bridge. Opposite the power house are two steel sections 15 ft. long, upon which steel pen-stocks 6" diameter lead to the turbines. By controlling the supply from the two canals, the turbines can be driven from either canal, or during the irrigation season, if either canal should break through the retaining wall in the canyon, as sometimes happens, that portion below the canyon can be supplied from the other canal through the 8-ft. syphon, and thus preserve the crops in the valley until the damaged canal is repaired.

The power house does not call for any special reference, being laid out on the usual lines.

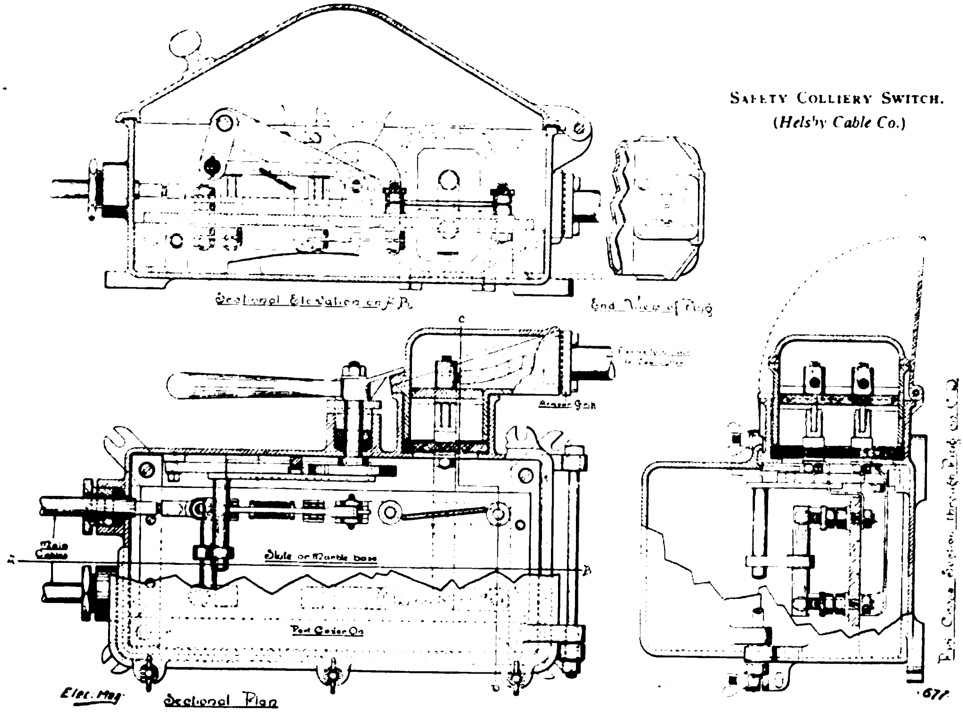
A three-way transmission line passes up the river, and taps into the Utah Light and Railway Company's line at Ogden. From the power house to Salt Lake City is eighty-two miles. Transmission lines of copper are carried on 40-ft. round cedar poles, 120 ft. apart. The insulators have been relied upon entirely for insulation, and are of the Locke brown-porcelain type, in three pieces, cemented together. Each was subjected to a factory test of 120,000 volts before acceptance. The output of the plant is 3,000 h.p., and a third unit will shortly be installed.

There are several power companies operating in Utah, and a large amount of irrigation is undertaken. An interesting system is that from American Fork Canyon to Utah Lake, where transmitted electric power is utilised to drive four 100-h.p. pumps, raising 500 cubic feet of water per second into a system of five large canals which irrigate the Salt Lake Valley.

SAFETY SWITCH FOR COLLIERY WORK.

THE advantages — we might say the necessity — for providing a reliable safety switch for colliery use has long been recognised. To automatically ensure that the circuit can never be opened either at switch or plug contacts in an inflammable atmosphere is the function of such a switch, and when this condition is realised, a really safe switch is the result. The St. Helens Cable Co., to whose exhibit of cables at the Colliery Exhibition we referred last month, had also on view a special safety gate end switch which we also mentioned, promising to illustrate the same in this issue.

The switch is so designed that it is im-



SAFETY COLLIERY SWITCH.
(Helsby Cable Co.)

possible to raise the cover unless the switch is off, and it is also impossible to close the switch after the cover has been raised. A disc is attached to the spindle of the switch arm, and in this a small notch is cut. When the cover is down it depresses a vertical lever by resting upon its upper end, and this keeps the end of another lever out of the notch, leaving the disc free to revolve. It will be seen that the switch can then be opened or closed while the cover is down. The cover can, however, only be raised when a pin, which is attached to it by a lug, is free to leave a slot in the disc; and the latter is never permitted to do this except when the circuit is broken by the switch. Immediately the cover is raised, the lever rises under the action of a spring and enters the notch, preventing the switch being closed until the cover is lowered. The box itself is made gastight, and it will be seen that no spark can possibly occur except when it is closed. For bringing the cables into the box there is a plug which is not gastight, because, as is obvious from the illustration, it cannot be removed until the circuit has been broken by the switch. This additional precaution is effected by a projection on the switch handle, which extends over the plug and prevents its removal until the switch handle has been turned round.

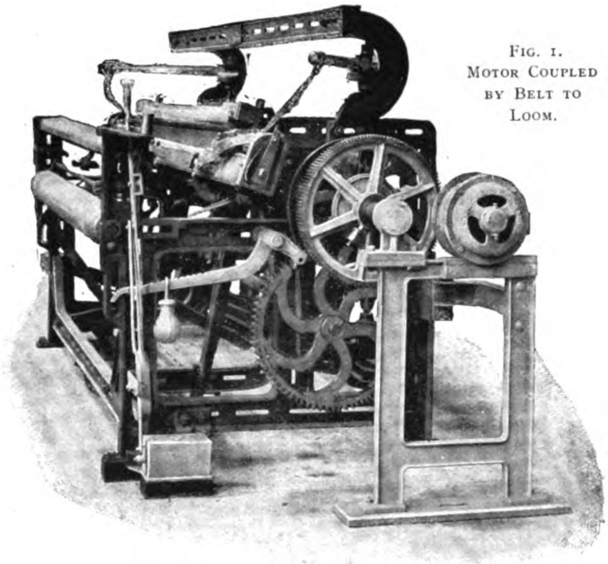


Fig. 1. Motor Coupled by Belt to Loom.

ELECTRIC DRIVING FOR WEAVING MACHINERY.

The *Allgemeine Elektricitats Gesellschaft*, of Berlin, have recently published a short illustrated pamphlet describing the application of polyphase motors to the driving of weaving machinery. The introduction of steam was the most important factor in the destruction of the old system of weavers carrying on their industry in their own dwellings. Economy necessitates the concentration of as many machines as possible in the immediate neighbourhood of the prime mover. The advent of the continuous current motor effected no alteration in this state of things, except that it provided a more efficient method of distributing the power from the prime mover to the various machines in the factory. This had the further effect of enabling larger, and therefore fewer, steam-engines to be used, producing a considerable increase in economy. The pamphlet under consideration states that the more recent introduction of the polyphase motor is infusing new life into the almost moribund system of carrying on weaving in the workers' cottages. The factory system is not likely to be misplaced for work carried out on a large scale. There are, however, many classes of woven goods which are only made in small quantities, or even singly to fill special orders. This kind of work is exactly suited to the cottage industries, provided only that cheap driving power of a character requiring little

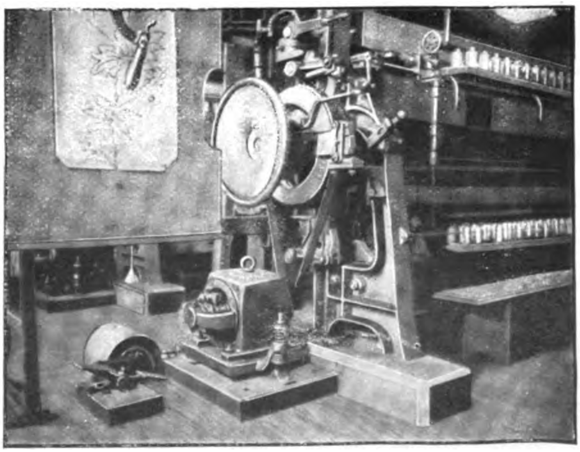


Fig. 2. Motor Coupled to Embroidering Machine.

or no skilled attention can be made available. These requirements are exactly fulfilled in the polyphase motor, with squirrel-cage armature, driven from a central supply station.

The *Allgemeine Elektricitats Gesellschaft* append at the end of the pamphlet a long list of firms to whom they have supplied in all between 8,000 and 9,000 motors of this class for driving weaving machinery, either in the factory or in the workmen's homes. The accompanying illustrations, which are reproduced from the pamphlet in question, show some of the methods of driving most commonly adopted. Fig. 1 shows a belt-driven, and gear-driven, weaving machine respectively. Fig. 3 shows a motor with a special foot-switch for stopping and starting, driving an embroidering machine. This form of switch is convenient for use with other machines which require the use of both the workman's hands on the work.

GENERAL POWER NOTES.

Power Papers at the International Congress.

THERE is to be no lack of current opinion as to the generation transmission and distribution of electrical energy at the forthcoming St. Louis International Congress. All Power matters are to be treated under Section D, and in the list of papers down for reading we notice the following from men of wide experience of the subject : The Maximum Distance to which Power can be Economically Transmitted," by Ralph D. Mershon. "The Theory of the Single Phase Motor," Prof. C. P. Steinmetz. "American Practice in High Tension Line Construction and Operation," Dr. F. A. C. Perrine. Under Section E, treating of the distribution, are placed important papers on American Meter Practice, Protection and Control of large H. T. Distributing Systems, Motor Generators and Rotary Converters, Underground Mains, and Storage Batteries as an adjunct to Station equipment.

Electric Power in Construction of Lake Baikal Railway.

THE construction of the loop line around Lake Baikal, for connection with the Trans-Siberian Railway is being materially assisted by electric power. Russian engineers have had some experience with electric drills, and so valuable have they proved that in the present instance a power-house has been laid down for furnishing energy to about thirty such drills. It comprises a 120-h.p. steam generator driving a three-phase alternator supplying current at 2,200 volt pressure to four sub-stations, through cables laid alongside the tracks. In the sub-stations are motor generators which supply direct current for operating pumps, drills, ventilators, and also for lighting purposes. In the length of line mentioned is a stretch sixteen miles long and in this thirteen tunnels are required totalling two and a half miles long. The installation was put down in less than three months in spite of the temperature being fourteen degrees below zero.

Electric Plant at St. Ouen.

THIS plant is being rapidly developed, and will be in operation, it is hoped, by January 1, 1905. The electrical equipment comprises four Brown-Boveri-Parsons turbo-alternators of 5,000 kwts. each at 750 r.p.m., supplying triphase current at 5,000 volts, twenty-five cycles. Each set has a separate surface condenser, with air and circulating pumps for each, operated by D.C. motors. For exciting and local purposes there is a turbo-dynamo of 300 kwts. at 1,700 r.p.m. with separate condenser, and two motor-generators of 357 kwts. each. A storage battery of the Tudor type and of 2,300 a.h. capacity is used as a reserve for the D.C. circuits. In case of breakdown of the ordinary turbine oil pumps, a central steam-operated pump supplies oil under pressure to the different sets. The turbines are designed to work with steam at a temperature not exceeding 360° C., the steam-pressure being about 180 lbs. per sq. in., the consumption of steam not to exceed 15 lbs. per kwt. hour. These conditions are by no means stringent, and it is expected that the trials will show much better figures.

A French Blast Furnace Gas Plant.

AT the Elba Co.'s blast furnaces at Lorto-Ferraris, an interesting gas-electric plant has lately been put down by the French Westinghouse Co. The central station, which is equipped with a twenty-ton travelling crane, contains three generating sets, each consisting of a 100 kwt. 250 volt dynamo belt-driven by a Delamere gas-engine of 200 h.p. The distance between shafts of the two machines comprising one set is 36 feet. The blast furnace gases used are first passed through a Theisen washer operated by a 5 kwt. D.C. motor. In the blowing-engine building there is a 250-volt dynamo-belt driven at 450 r.p.m. by a steam-engine of from 300 to 370 h.p. at eighty-seven r.p.m. The exhaust of this machine and of the 1,200 h.p. blowing-engine is taken to surface condensers placed underground. Steam has been retained as motor-power for setting the plant in operation, as otherwise a complicated installation of gas producers, washers, &c., would have to be put down. There are six boilers some distance from the Central Station power-house, three of which are of the double-furnace Cornish type, fired by coke-furnace gas. The other three are multitubular fired by the blast-furnace gases. For charging the ore, limestone, and coke, two elevators are provided, equipped with two enclosed motors of fifty-five h.p.

Electricity in Spinning and Weaving.

M. J. Garcin, whose article on the above subject appeared last month, wishes us to state that the particulars and illustrations contained in his article were kindly furnished by La Société Alsacienne de Constructions Mecanique, Belfort, France.

A classified list of Traction and Transport articles will be found in the World's Electrical Literature section at end of magazine.

Electro-Pneumatic Control of Electric Trains.

FOR large and heavy cars requiring very powerful motors, the latest form of controller is the Westinghouse Unit Switch Turret controller. This takes its name from the fact that it is turret-shaped. It consists of a number of radially grouped circuit-breakers, or unit switches, closed by air pistons working against powerful springs, which open the switch contacts when the air-pressure is removed. Fig. 1 shows a turret controller with its cover removed, and Fig. 2 illustrates its position on the underside of a motor-coach. The fifteen separate circuit-breakers, or "unit switches," employed, are secured to a circular base, and provided with a common

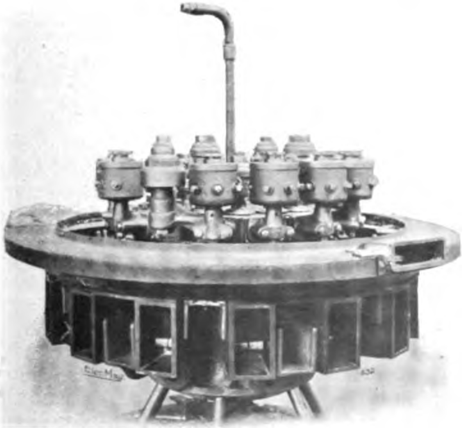


FIG. 1. UNIT SWITCH TURRET WITH COVER REMOVED.

magnetic blow-out coil at the centre. This single coil is a special feature, as it secures the ideal condition of maximum blow-out effect with minimum weight and space; and the number of parts and the amount of wiring necessary is very much reduced. Further, the use of a single blow-out coil enables it to be made of greater magnetic strength than could be the case if a number of smaller coils were used—one to each switch. The air pistons actuating the radial switches work in vertical cylinders; and the air-admission is controlled by electro-magnetic needle valves, which, together with the cylinders, project above the main base-casting of the turret, as seen in Fig. 1. A single pipe-connection supplies compressed air to a central reservoir-chamber, and ports around the latter admit air to the various magnetic valves, and thence to the cylinders; this construction reducing the amount of air-piping and joints to a minimum.

A view of the turret controller partly in section is given in Fig. 3, which will explain the construction of the switches and their arrangement with respect to the blow-out coil and central compressed-air chamber.

The contents of each switch are enclosed in a vulcabeston box or arc-shield, and the magnetic lines from one top and one bottom pole pass through each box, in a direction normal to that of the line of break of the switch, that is to say, horizontally. The strength of the blow-out is such that test currents up to 18,000 amperes have been repeatedly and successfully broken, the burning at the switch contacts being negligible. Each switch is closed by the action of the air-pressure in its cylinder, a powerful helical spring behind the piston being compressed at the same time. When opening and closing the switches, a spring in the moving arms comes into play and brings about a rolling and sliding motion of the contents, and so keeps their surfaces in good condition and

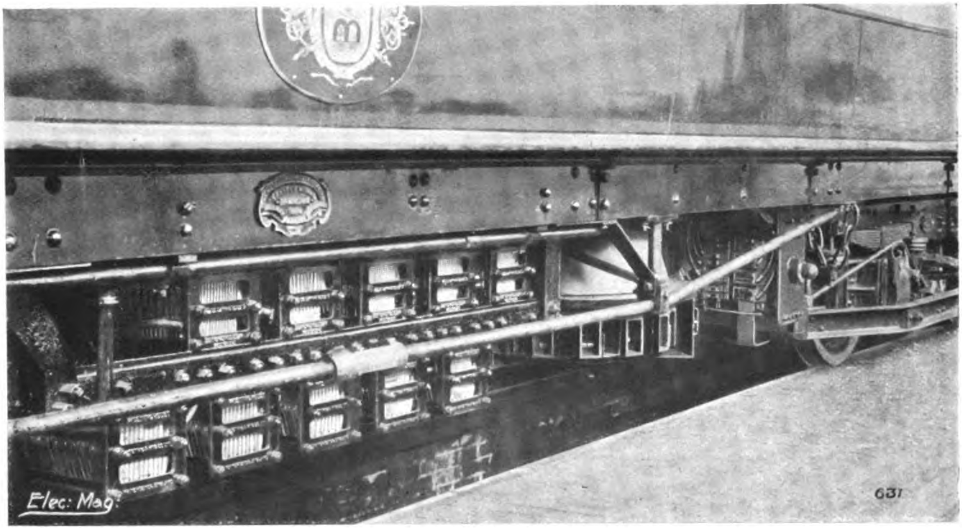


FIG. 2. TURRET CONTROLLER ON MOTOR COACH.
(The reversing switch can be seen on the right and the resistances on the left.)

prevents all tendency to burn or weld. Copper shunts are provided for all working pins and bushings in the switches; and the contact plates—which are easily removable—are of ample area. When the exhaust-port of the cylinder is opened, the spring under the piston drives the latter up and opens the switch. The switch terminals and the switch parts are insulated from the circular base-plate of the controller by sheets and bushings of vulcabeston. The terminals are on the opposite side of the base to the switches, the cables being thereby divided off from the latter. The low-tension terminals on the magnet valves are also well separated from the comparatively high-tension switch terminals. The magnets and valves are enclosed by a hinged truncated cone-shaped cover which can easily be removed; and the switches are enclosed by a revolving cover, the halves of which slide or telescope within each other.

In addition to the turret controller, just described, a complete motor-coach equipment includes a reverser, an automatic excess-current, and no-voltage return relay, one or more small master-controllers, and a switchboard for the controlling of the car-lighting, compressor, and battery circuits. The reverser is operated by an air-motor, the admission of air being controlled by electro-magnetically operated valves similar to those on the turret controller, and is of substantial and simple design. Fig. 4 shows its construction. The overload and no-voltage return relay is connected with the operating magnet of one of the cylinders in the turret, this cylinder actuating the switch which acts as main circuit breaker. The no-voltage part of this relay, which is mounted on the end of the case, is of considerable importance, its function being to prevent the sudden restoration of full voltage to the motors and consequent flashing thereat, after any unforeseen interruption in the supply of power, due to a break in the third rail, something going wrong with the contact shoes, a momentary interruption of the supply to the line, &c. When this no-voltage device acts, it causes the controller to go back to a point with high resistance in circuit, the latter then gradually and automatically "notching out" the resistances as soon as the supply is resumed. It should be noted that the no-voltage action of the relay is not so instantaneous as to take notice of instantaneous interruptions due to the car contact shoe passing over points or crossings; and also that it does not act when the supply is suddenly cut off and then suddenly comes on again; hence the term *no-voltage return relay*.

The master controller has five notches for forward, and five for backward running, in addition to the neutral point. At the first "forward" notch, the emergency brake valve is set. At the second, the main supply circuit is closed and the reverse set. At the third—known as the shunting notch—the motors are connected in series with all resistances in. At the fourth, an automatic acceleration device comes into action, and the controller continues notching-up, provided it is not checked by the limit switch, till the eighth and last series notch is reached: the limit switch coming into play in order to maintain an uniform accelerating current. As the controller

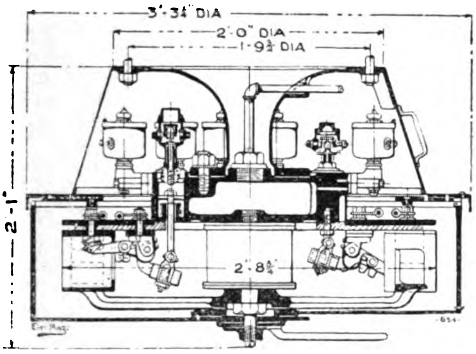


FIG. 3. SECTION THROUGH TURRET CONTROLLER.

drum is rotated, the pistons in the turret are actuated in due order, and the corresponding switches are closed. When the controller handle reaches its last notch, the turret switches which have already been put on are simultaneously opened, and a number of others simultaneously closed; this making the parallel connections for the motors. Then, subject to the action of the limit switch, the controller automatically notches up to full parallel, and the highest speed point is reached. It is important to note that should the driver throw his handle over to full parallel at the start, the controller will still work automatically and gradually through all the series and parallel positions, so that no harm can come to the motors. A further advantage of this automatic acceleration is that it ensures the utmost economy in power consumption. Thus, with non-automatic control it has been found that from 10 to 15 per cent. more energy is consumed.

An ingenious safeguard is provided in case the motor-man should lose his hold of the controller handle through inadvertence, accident, or sudden illness. The handle, when released, flies back to its neutral position by spring action, and in so doing interrupts a circuit through the magnets above the air-pipe, the effect of which is to open a valve and allow the air in the main pipe of the air-brake system to escape, with the result that the brakes are applied immediately throughout the train. When the brakes are not required to act, however, as in reversing, their above-mentioned automatic application may be prevented by passing the controller handle rapidly over the neutral notch. In running backwards, the operation of the controller is similar to its operation with forward-running.

The motor-coaches that are being equipped for the Metropolitan Railway (London) will be fitted with four 150-h.p. motors, *i.e.*, 600 h.p. in all; and each coach will weigh approximately thirty-nine tons. The full-length train will consist of two motor and four trailer coaches; and it will be possible to split it up into five, four, three, two, or single coach trains as the density of the traffic decreases. The unusual power of these equipments is the reason for the large number of resistance steps in the controller, there being eight series and eight parallel positions. Nevertheless, the weight of the turret resistances, reverser, and pneumatic controlling gear is less than that of an ordinary electro-magnetic control equipment. The cables are encased in asbestos slate mouldings, so that the fire-risk is practically negligible.

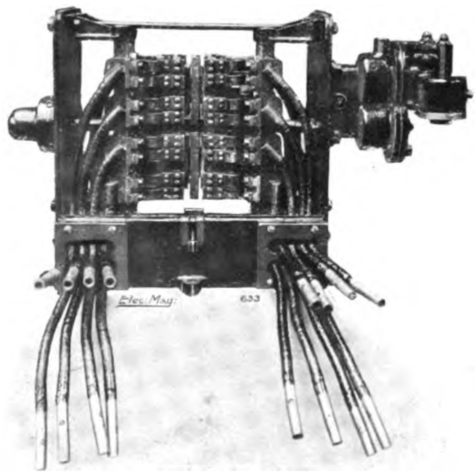


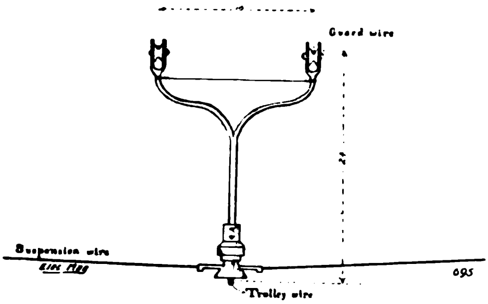
FIG. 4. ELECTRO-PNEUMATIC REVERSING SWITCH.

The City of Buenos Aires "Metropolitano" Tramways Company.

By *HENRY H. FISHER.*

THE "Compañia Alemana Transatlántica de Electricidad," which is a branch of the Allgemeine Elektricitaets Gesellschaft of Berlin, as proprietors of the Metropolitano Tramways Co. of this city, obtained on December 16, 1898, a concession for converting their horse-traction system into electric traction. The work for this conversion was commenced in July 1903, and the first section was inaugurated on May 15, 1904. This section is composed of the line running from Recoleta to the Tramway Car Station situated at the corner of Calle Constitución and Alberti. The length of these lines is 12 miles, and the total

extension of all the company's lines being 18 miles, it can be said that already two-thirds are traversed by electric cars. The actual service on this first section is only provisory. When the conversion is totally completed, four services will be established which will conduct passengers from the centre of the city (Plaza Colon) to the Central Argentine Railway Station (Retiro) the Great Southern Railway Station (Plaza Constitución), the Western Railway Station (Plaza Once), and to other suburbs of the city. For these services the company employs ninety cars, of which sixty are motor-cars of twenty-eight passengers capacity, and the rest trailers. The car station already mentioned, besides being spacious enough for housing these cars, will be fitted with repair-shops. The power is supplied by the power-station of the "Compañia Alemana Transatlántica de Electricidad." The overhead trolley system is employed on the whole line, and fed at a tension of 500 volts. The trolley wires are suspended from columns and rosettes, and



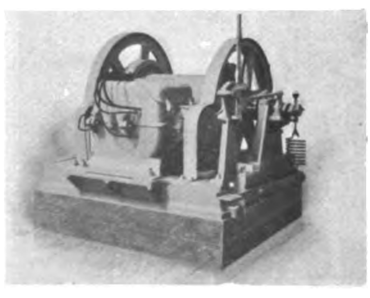
New Guard-wires for Buenos Aires Tramways.

protected against contact with the telephone lines by a guard in form of a Y with two wires, which will be clearly seen in the accompanying sketch.

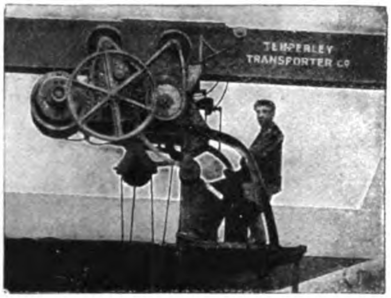
This protection has been declared obligatory by the municipality, so that the other systems of protection which have been adopted by other companies will have to be changed for the new guard-wire. The systems chiefly employed here are: A strip of wood directly fastened to the trolley wire, by the Anglo-Argentine Tramways Co.; two wires in a horizontal plane, by the "La Capital" Tramways Co.; two wires in a vertical plane, by the Buenos Aires and Belgrano Tramways Co. The new system, as will be seen, does not differ much from the old ones, excepting the height of the Y, which is $23\frac{1}{2}$ in. above the trolley wire. The arrangement, in the writer's opinion, destroys the good look of the overhead system, and will not prove as efficacious as is desirable; the telephone wires, in case of falling on the protection, have a tendency to take the form of a spiral, which would bring them into contact with the trolley wire on account of the great height of the Y. All the work has been done by the Union Elektricitaets Gesellschaft, and is similar to that of the Anglo-Argentine Tramways Co., which was also executed by the same company. A description of the construction of this line will appear in a subsequent issue.

ELECTRICAL TRANSPORTERS.

The rise and development of transporting machinery may be regarded as phenomenal. Introduced at the outset for the unloading and loading of goods, the application of electro-motors to industrial appliances of every description has naturally led to their employment in connection with transporting machinery. It would not be too much to say that this circumstance is largely attributable to the use of transporting apparatus in the handling of coal for power houses. With electric power "on tap" the most feasible arrangement was to drive the transporter by electro-motors, and from such a beginning the standardisation of electric transporting apparatus could easily continue. The Temperley Transporter Company have long been recognised as experts in work of this character, and it is interesting to note that in developing their many types of transporting machinery they have largely introduced electric power. We give a number of illustrations which will serve to add further testimony to the flexibility and ease of control afforded by electro-motors. Wherever possible electric power should be installed in preference to steam, and even if a supply is not available it is extremely advisable to instal a special power plant where the transporters are constantly required. In comparing electricity with steam it is unnecessary for us to emphasise the many disadvantages possessed by the latter. A typical transporting plant has been installed by the Company at the Metropolitan Electric



Motor and Hauling Gear for Transporters.

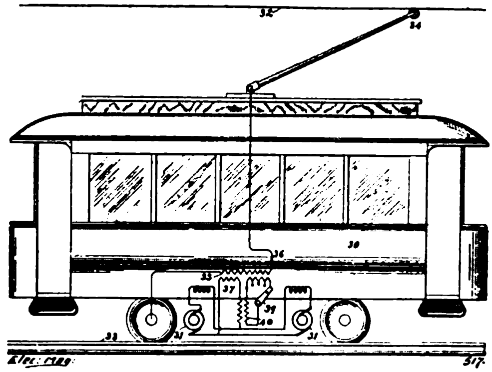


ELECTRIC TELPHER TRAVELLING ON GIRDER.

Supply Corporation's Willesden Station. A battery of boilers being placed at right angles to the water way, the use of a transporter for dumping coal into the main hopper is rendered a simple matter. The coal in the barges is filled into automatic dumping skips, which are taken up by the transporter, and emptied at any point along the line of coal bunkers. As small coal for mechanical stokers is used, the skip is automatically dumped without lowering, for the question of breakage needed no consideration. An electrically driven friction drum engine operates the installation, the load being 30 cwt., lifting speed 200 ft. per minute, and transporting speed 700 ft. per minute. The transporters are made also in radial and portable types. An electric travelling crab is also manufactured by the firm. It is specially arranged to grab coal from the coal store, and transport it to coal bunkers to any desired position. It has a lifting capacity of 3 to 5 tons, at a speed of 60 to 90 ft. per minute, and a travelling speed of 400 to 800 ft. per minute. The crab is furnished with current from a small trolley, and is controlled from a small cage travelling with the crab. We illustrate also an electrically driven crab of somewhat similar design, built for hoisting and transporting hot steel ingots from soaking pit furnaces to the middles. Appliances of this sort are extremely useful, more especially as they are adaptable to almost any position by reason of the ease with which they will pass round curves, take inclines, and travel any distance, being under the complete control of the operator. They are specially arranged to run on aerial rope-ways.

LAMME RAILWAY MOTOR.

THE accompanying illustration depicts the arrangement of motors and transformers on Mr. B. J. Lamme's proposed single-phase railway. A railway car is shown as equipped with two motors, which receive energy indirectly from an alternating-current supply circuit, one side of which is an overhead conductor and the other side the rails. Obviously, the well-known third-rail construction might be employed, if desired, and also completely insulated supply and return conductors, either both overhead or both beneath the car. The energy from the supply circuit traverses the primary winding of the transformer (36). This is provided with a secondary (37) of such dimensions as to provide the reduced voltage necessary for the motors, and, as shown, the two motors are permanently connected to this secondary in parallel. The motors may, if desired, be permanently connected together and to the supply circuit in series. The transformer is also provided with a secondary winding (38), the active length of which is variable by means of a suitable switching device (39). Included in circuit with the secondary is the primary of a series transformer (40), the secondary of which is included in the circuit of the motors and in the secondary of the main transformer. It will be readily seen that a high voltage suitable for long-distance transmission may be supplied from the main circuit to the primary of the transformer (36), and that a low voltage suitable for motors may be



CONNECTIONS OF LAMME MOTORS ON CAR.

supplied thereto from the secondary (37). To vary the voltage supplied to the motor, the variable voltage of the secondary (38) may be impressed upon the circuit (37) through the series transformer (40), and by reversing the connections of the secondary this variable-impressed voltage may be employed to both subtract from and add to the voltage of the circuit through all its varying values, and thus provide the necessary variation of motor speed from zero to the desired maximum. It will be seen that with this combination and arrangement of apparatus, the motors may be designed for such voltage and such current as are best adapted for their operation, and that the controller may be designed for some other voltage and current which are best adapted for its operation, and that

ELECTRIC TELPHER IN CABLE STORES.

they may then be joined together and to the high-voltage supply circuit so as to operate together harmoniously and effectively. Various arrangements of circuits and apparatus for securing a variable electromotive force for application to the motors may be employed.

ELECTRIC TELPHERAGE IN A CABLE WORKS.

THE Woolwich works of Siemens Bros. and Co. are fitted with an interesting telpher line for the transport of light goods about the yards and shops. Electric traction in shops and yards has always been discounted by reason of the trolley wire needed, but where battery locomotives (as referred to in another article) are not expedient, the problem is well solved by a telpher line, which can handle light goods. The line in question comprises rail and cable portions, the latter passing over very busy yards. The telpher is built of a steel frame carrying the running wheels, to each spindle of which a chain wheel is secured. The motor is suspended from the frame, and has on its shaft a chain wheel working the two running wheels through a triangular drive. The frame also supports the cage and hoisting gear, the latter comprising a drum driven by worm from the motor spindle by a suitable clutch, which permits of the motor being used for hoisting or running. Brakes for both motions are also fitted, together with an automatic brake which is applied to the telpher when current is cut off: our illustration depicts the telpher on a rail section in the stores. The travelling speed is 1,200 ft. per minute, hoisting 40 ft. per minute, and the maximum useful load 15 cwt. The line is in continued daily use, conveying 100 to 150 tons of miscellaneous goods per day. We are indebted to Siemens Bros. and Co. for the illustration reproduced.

PROGRESS IN THE METROPOLITAN ELECTRIFICATION.

OF the total 67 miles owned and worked by the London Metropolitan Railway Co., some 26 are in process of electrification, and work is now being pushed on very rapidly. The electrified section includes the northern part of the inner circle, a length from Baker Street to Harrow, and a section from Harrow to Uxbridge, through Ruislip, also a branch from Westbourne Park on the G.W.R. to Hammersmith. There will be connections to the Midland, Great Northern, Whitechapel, and Bow, and East London Railway. In addition the north inner circle will be connected to the south portion of that route, now under electrification by the Metropolitan District Railway Co.

The "Met" dates back as far as 1863, when it was worked by the G.W.R., and comprised a short line from Bishop's Road, Paddington, to Farringdon Street, a distance of $3\frac{3}{4}$ miles. Late in the same year the system was taken over by the Metropolitan Railway Co., and has since been developed to its present proportions. In 1897 the District Co. obtained Parliamentary powers to "electrify" its lines, and in the following year the Metropolitan Co. procured similar and more extensive powers. In 1900 the District was provided with identical authority, though in 1898 both companies had spent £20,000 on an experimental line between Earl's Court and Kensington High Street. In 1901 the famous dispute between the companies as to the choice of continuous or three-phase current for the working of their respective lines was, as will be remembered, decided in favour of the District Co., whose advocacy of continuous current was upheld and loyally submitted to by the Metropolitan Co. The latter company, however, obtained powers to supply its line from a distinct station, while the District derived energy from a large power house supplying other tube lines.

The Metropolitan Co.'s station is at Neasden, near Willesden, and its equipment is being rapidly pushed forward to completion. Our contemporary the *Tramway and Railway World* in its July issue gave a long illustrated account of the plant and rolling-stock for the line, and from this article we have obtained the details here given.

The station is designed for four 3,500-k.w. turbo-alternators, but three will at present be installed. Steam at 180 lbs. pressure will be obtained for these from ten water tube boilers, and each turbine will have its own barometric condenser. Three-phase current, $33\frac{1}{3}$ cycles, at 11,000 volts, will be furnished by the generators direct to eight sub-stations. At these the alternating-current pressure will be reduced and fed to rotary converters, whence it will be conducted to the collector rails.

The permanent way has been laid by the company's staff, while the ordinary steam service has been maintained uninterruptedly. Two conductor rails are used, the positive 16 in. outside the outer track rail, and the negative between the rails. The motor-cars are fitted with four 150-h.p. motors, there being cars at both ends of the train, thus giving 1,200 h.p. per train of six carriages. The fullest protection against fire has been made. The Westinghouse unit switch system of train control described on page 145 will be used for the operation and regulation of the motors. The British Westinghouse Co. has been responsible for the complete conversion from the power-house and sub-stations to the track and rolling-stock.

GENERAL TRACTION NOTES.

An Electric Railroad Repair Shop.

IN America little or nothing is done by halves. An up-to-date electric railway should have a modern repair shop. The Columbus Ohio R.R. has such a shop and undertakes all its own repairs. The building comprises armature winding, brass foundry, rail bond, and trolley fittings departments. The company has a complete system for renewals and repairs and undertakes these on the shortest notice. *The Street Railway Journal* in a recent issue describes the shop in detail.

Electrical Progress in Portugal.

THE admirable tramway service which was inaugurated in Lisbon about the end of the year 1901 by a British company has led to several concessions of a similar kind. An electric tramway route was opened a little time ago from Cintra to Collares, and will shortly be extended to the sea-coast. Following the example of Lisbon, of which the principal streets have been illuminated by electricity since last summer, many of the provincial towns in Portugal are now adopting electric lighting. Consequently, there is much activity in this direction at the present moment, a fact to which the attention of our readers may well be directed.

Electric Railway Traction around New York.

THE activity displayed by the New York Central and Pennsylvania railway companies in converting their lines for electrical operation has brought another company—the New England R.R.—into line for the electrification of its lines entering New York. Its branch routes have been electrically operated by trolley trains for some time past, but only the activity of other companies in the neighbourhood of New York has caused this other step to be taken. The general development of heavy electric traction around that city is expected in five years, to double the number of passengers now carried. Some novel train despatching schemes are being worked out for the prevention of accidents, these chiefly comprising arrangements for cutting off the power and applying the brakes from headquarters.

The Receipts of Swiss Tramways.

THESE were recorded in a recent issue of the *Schweizerische Elektrotechnische Zeitschrift* as follows:

		March. Frcs.		Jan.-March. Frcs.
Municipal Tramway, Zürich		128,787	..	378,110
	1903:	119,764	..	343,707
Schwyz-Seewen Tramway .		1,720	..	5,351
	1903:	1,683	..	5,156
Lucerne Tramway . .		25,766	..	75,452
	1903:	24,230	..	69,151
Basel Tramways . .		104,268	..	368,683
	1903:	101,101	..	329,081
Birseck Railway . .		7,462	..	23,421
	1903:	9,770	..	24,588
Limmattal Tramway . .		5,468	..	15,646
	1903:	6,256	..	16,119
Wire-rope railway . .		747	..	2,066
Rigiviertel	1903:	1,117	..	2,563
Zürich-Oerlikon-Seebach .		19,291	..	59,826
	1903:	20,498	..	59,253
Birsigtalbahn . . .		14,290	..	45,890
	1903:	14,942	..	43,45

Railway Electrification at Cape Town.

In an article on the electrification of steam railways, the *Cape Times* points out that it is clear that unless some means be adopted to relieve the congestion of traffic during business hours on the Cape Town and Wynberg section of the suburban railway, it will be impossible for men employed in the city to live anywhere along the route. It is argued that if the substitution of electric for steam traction should be found to solve similar difficulties in the case of the Liverpoor and Southport railway, equally satisfactory results should follow the adoption of electrical traction at the Cape. This article serves to suggest inquiry on the part of our readers who are interested in the export of railway electrical plant.

Electric Traction in Shanghai. A New Development.

Proposals are now being invited by the municipal council of the foreign settlements at Shanghai for a concession for constructing and working about twenty-three miles of electric tramways in the streets of that city. Tenders were first invited for a similar concession in the year 1898, and a contract was then arranged between the municipality and the Brush Electrical Engineering Company, by whom the undertaking was transferred to the British Electric Traction Company. In order to ensure the carrying out of the specifications relative to the present scheme, it has been decided that a deposit of £5,000 shall be payable upon the signature of the contract. The new routes projected, which are divided into five sections involve the construction of about five and three-quarter miles of double track and ten and three-quarter miles of single track. The specifications require the use of span-wire construction for double tracks, and bracket construction for single tracks, with iron or steel poles in each case. The annual rental demanded by the City Council is £150 per mile of double track, and £100 per mile of single track.

The Output of Railway Motors.

The following calculation of the output of motors in railway service is given by N. Müller in a recent issue of the *Elektrot. Zeitschr.* The motor parts which limit the output by their heating effect are the field and armature coils, for both of which the ohmic losses should be firstly considered, while the iron losses have an influence only on the cooling of the copper conductors. In tramway service, as well as with short railways, the same loads will periodically be observed after a run in either direction has been completed. The motor after a given time will assume a final temperature at which its various parts will, on account of their temperature, give off the same amount of heat which the motor has to absorb during the same period in virtue of the current loads, this final temperature having to be less than 75° C. above the surrounding temperature. The total heat supplied to the armature coils during several intervals of time (t) with different current intensities (i) is $\Sigma i^2 t$, the iron losses having no influence on the heating of the copper conductors. As regards the different iron losses (w) during the different intervals (t), the average iron oss will be $\Sigma \frac{w\,t}{T}$ where T is the time of a complete run in either direction, including stoppages. This average iron loss will correspond with a given cooling of the copper conductors, to be ascertained by experiment. The same is true in the case of the field coils, where, however, the iron losses are less. As the average iron loss ascertained corresponds with a given tension, the oscillating current load may be replaced by a permanent load, the current intensity of which has to be calculated from $\Sigma \frac{i^2 t}{T}$ and the tension from $\Sigma \frac{w\,t}{T}$. The average iron losses and the average current intensity being ascertained, the curve will allow of concluding whether the average current intensity thus determined in connection with the iron loss $\Sigma \frac{w\,t}{T}$ is inferior to the permanent output.

Electric and other Street Railways in U.S.A. and Canada.

Some valuable tables setting forth the progress in electric street traction in U.S.A. and Canada have recently been issued by *American Street Railway Investments*. These tables compare electric lines with steam, cable, and horse, and the progress recorded is very encouraging. In U.S.A. there are 1,187 electric roads, representing a route mileage of 29,212 and over 70,000 cars. Compared with this the cable and steam lines have together a track mileage of 358 and 4,839 cars of all classes including locomotives, the horse lines being well in the rear with 260 miles and 1,165 cars. The grand total for all classes of street railways is 29,830 track miles, and 76,186 cars for United States. In Canada the figures are not so startling as might be expected. There are forty-two electric roads with a track mileage of 830 and 2,416 cars of all classes (motor, trailer, service). The cable and steam roads are disproportionately numerous there being a track mileage of sixty with eighty-eight cars and locomotives. The cable and steam lines have almost doubled their track mileage, but (if the figures are correct) the rolling-stock has been reduced some 11 per cent., the locomotives being almost halved. There are no records of any horse cars in Canada.

Comparing the records of electric railways of the various groups of American States, some interesting figures result. In the central States the most marked advance is noticed. Here there are 314 lines in thirteen states, and during 1902–3 the track mileage has been increased from 9,533 to 11,073, and the motor-cars from 16,654 to 18,524. The eight Eastern States, which include New York, show a lower track mileage than the Central, but their rolling-stock is much more numerous. The nine Southern States are at the bottom of the electric list, but they are slowly increasing their mileage and cars. The fourteen Western States show the greatest number of steam and cable lines, and the Eastern group, of horse lines.

Readers are referred to the World's Electrical Literature Section at end of Magazine for titles of all important articles of the month relating to Lighting and Heating.

The Life of Incandescent Lamps.

By the ASSOCIATE EDITOR.

FROM time to time results are published of tests which are carried out by private persons on lamps of different makes. It is probable that a large number of persons undertake such competitive tests in the course of every year, notably at central stations and colleges. Unfortunately few of these results ever see the light of day. The few that are published have little value for the buying public seeing that the names of the manufacturers are purposely withheld. Probably legal considerations are responsible for this result. In any case it is a misfortune. If any one were to ask the average electrical man which is the best lamp to buy, he would probably say that he always used So-and-so's lamps himself, but that he had little doubt other makes were equally as good. As has been frequently pointed out, the greatest room for improved efficiency lies with the lamp, and not with boilers, engines, dynamos, &c. The more's the pity therefore that we know so little where we are. Mr. Garrett has lately published in the *Electrical Engineer* results which he has obtained in the Electrical Laboratory at University College, Nottingham. Interesting as his figures and curves may be, they add but little to our general stock of information. The lamp-makers are called P, Q, R, and S; and he tells us that Q wins the race. Of what earthly interest is this to us? There is no doubt whatever but that great improvement is possible in the incandescent lamp as we already know it. But there seems to be little real competition between the makers except in the matter of price, and it is very doubtful whether this is to the interest of the consumer in the long run. We recall the fact that some years ago we undertook tests on the above lines for certain persons. The result was that a certain make of lamp seemed far better than any other. There seemed to be no sort of comparison between this particular lamp and its competitors. The sad fact however, remains to be told that the said maker soon ceased to interest himself in the manufacture of incandescent lamps, probably because, as was the case, his price was higher than the ordinary market price. Referring to Mr. Garrett's figures, he shows that after 1500 hours the lamps of the four makers took respectively 7.0, 6.75, 6.1, and 5 watts per c.p. If any one objects to the extreme old age of these lamps, and says they should have been replaced long before they had burnt for 1500 hours, it may be pointed out that these figures merely record extreme variations; only one make showed abnormalities in running; the other three ran more or less parallel to one another throughout, in so far as their curves are concerned. It is probably unreasonable to ask that commercial interests should be sacrificed to the common weal. Each maker has wrinkles of his own, which he probably thinks of great importance. If all these wrinkles could be thrown into the pool, so to speak, we might be able to make some real progress. All lamps are believed to be made in substantially the same way out of the same or similar materials. The results produced however differ, and this can only be due to greater care in manipulation, which is probably the secret, or to some unknown cause. Mr. Garrett does not even tell us whether Q, who is said to have won the race, charges more for his lamps than his competitors. If this is so, and if the fact were generally known, it might encourage us to pay more for our lamps with the knowledge that we were procuring a better article.

THE BARDON LAMP.

AN original feature in this lamp, illustrated in Fig. 1, is the damping mechanism, which effectually eliminates the "pumping" action so common in differential lamps, without interfering with the proper regulation. As shown in Fig. 1, *a* and *b* are carbon-holders, connected by a rope passing over pulley *g*, the weight of *a* tending to draw the carbons together. An axis *h*, a fly-wheel *v* is keyed, part of whose rim (Fig. 3) is in gear with part of the rim of cam *u*. The regulating mechanism comprises an axis *s*, bearing knife-edges cc^1, which rest on tempered-steel V-pieces. Sectors *r* and r^1 keyed to *s* carry chains *p* and *q*, to which soft-iron cores *n*, *o*, are attached. Solenoids *k* and *m* are excited by the main and shunt currents respectively, *s* turning one way or the other according as the attraction of *m* or *k* predominates. There is a flat on cam *u* (Fig. 4), to which we will refer later. The damping mechanism consists of two bored and polished cylinders ll^1, open at the two ends, and placed between the solenoids and plate P. Pistons X and Y, which are made an easy fit in *l* and l^1, carry rods screwed to cores *n* and *o* (Fig. 3). Dampers *l* and l^1 are connected by a tube I, which is opened or closed by an aluminium valve C. When the attraction of the shunt solenoid, or failing this the weight of counterpoise *t*, causes *o* to descend, *n* rises and the carbons should be and are brought closer without any damping action. On the contrary, when the carbons are drawn apart by the attraction of the main solenoid, *n* descends, piston X expels air through I and valve C closes, the result being that air is compressed in X and expanded in Y. Equilibrium is thus finally obtained without any hunting, part of the compressed air escaping between piston and cylinder in X, while similarly air is sucked into cylinder Y. When the lamp is in use the way in which these different mechanisms work in harmony is as follows. While the toothed portions of V and *u* are in gear, the whole system is linked together, and the

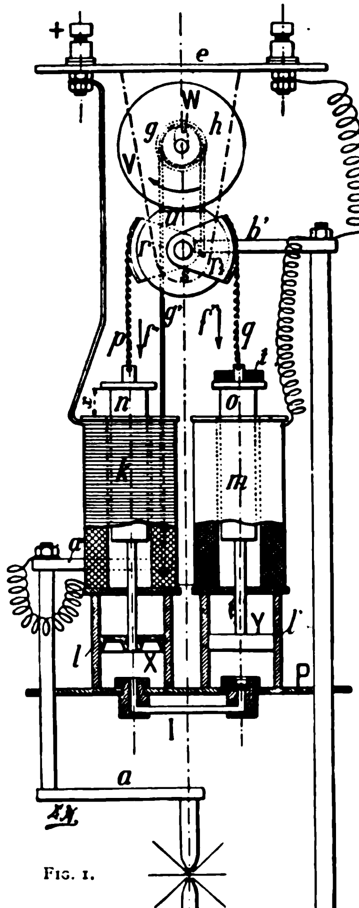


FIG. 1.

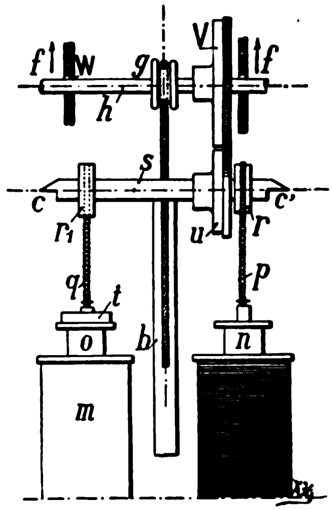


FIG. 2.

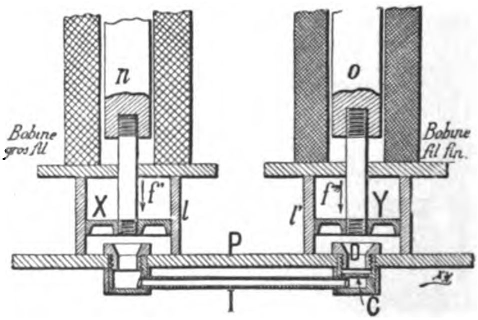


FIG. 3.

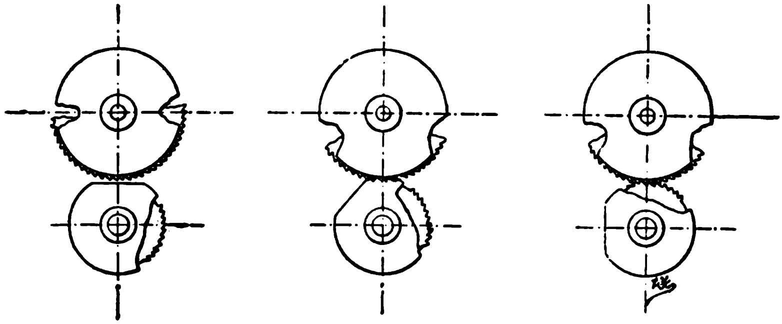
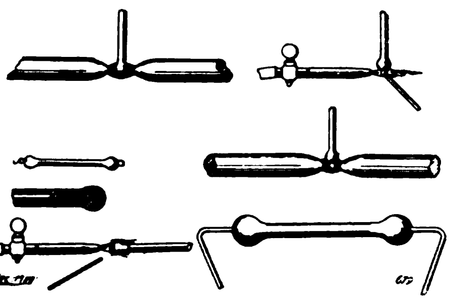


Fig. 4.

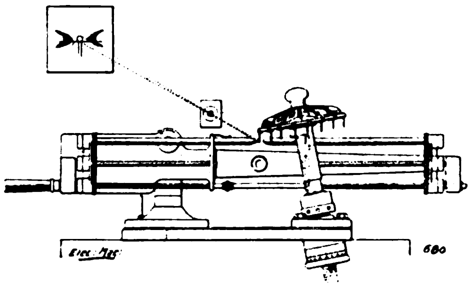
movement of the carbons when drawn apart is well damped, being accomplished without any modification. As soon as the carbons tend to come together core *n* rises and the toothed portion of the cam gradually falls out of gear with V, whose independent rotation is, however, prevented by the friction between the smooth portions of rim *u* and V, which are pressed together by the weight of the carbon-holders. The carbons thus gradually come nearer until the flat comes under V, when the lamp is at its proper regulating point and V is rendered independent of the regulating mechanism. As long as normal conditions prevail, the movements of *n* and *o* are very slight and unchecked by the dampers, and V turns according as the carbons wear. When there is a drop on the line, the attraction of *k* diminishes and weight *t* placed on *o* draws the same down, the carbons being thus brought closer until a position of equilibrium is reached. Suppose, on the contrary, there is a rise on the mains, or the resistance of the arc diminishes through defective carbons, *n* is immediately attracted, and successively the smooth and geared parts *u* and V are brought in contact. In order that *u* and V may come into gear easily, a slight vertical play is provided in the bearing of *h*.

THE MANUFACTURE OF NERNST LAMPS.

This question, though not at the moment of interest to any large section of manufacturers, may become so in the future. In any case it is of great interest to those who take delight in human ingenuity. As for the method of manufacturing the filament, little or nothing is known. The question of mounting terminal connections is a very difficult one, and the way in which this is done in America has produced good results. Our first diagram illustrates the method by which a platinum bead is first fused into the end of the filament, and then joined to a platinum wire, and our second illustration shows the method of fusing the end of the glower, preparatory to the insertion of the platinum. Taking the latter first, the filaments are mounted on a stand which can be revolved with the



Making Nernst Lamps—Methods of Fusing Platinum Bead to Filament.



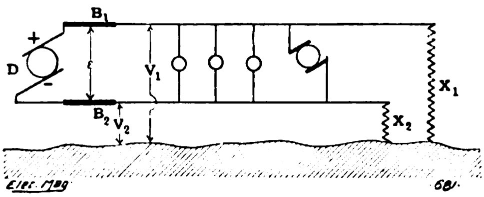
Making Nernst Lamps. Fusing End of Glower Preparatory to Inserting Platinum.

object of passing their ends through an arc flame. When the end is put into the heat of the arc, it is soon fused to a spherical globule, and as soon as this reaches a certain size, as shown by an image cast on a screen, the stand is revolved and the filament withdrawn from the arc. In this way it is possible to form the heads of the glowers at the rate of 350 in an hour, and as soon as the ends of the filaments have been formed into molten drops, they are ready for the insertion of platinum leading-in wires. This is done by softening the end in an oxyhydrogen flame, and plunging a platinum wire, which has been previously nicked, into the softened end. The wire burns off at the nicked point, and the portion which remains imbedded in the end of the filament is then fused by the arc for an instant. A suitable length of platinum leading-in wire is then joined to the head by the heat of the oxyhydrogen flame, and the whole is then complete. It used to be found that the contraction of the material at the ends caused the platinum

terminals, which were bound on with paste, to become loose. By the method above described the forces of contraction merely tend to hold the platinum bead, which is the real terminal, all the more tightly. The series resistance used with the lamp is made of fine iron wire, varying from 0.001 inch in diameter in the smallest lamp upwards. The wire varies in length from 4 to 12 inches, and in resistance from 25 to 80 ohms. The heater is made of platinum wire wound round porcelain, and covered with porcelain paste. After being made in the form of rods, they are heated and wound on a mandrel to a spiral form; and though this would appear to be a difficult and delicate operation, the accessories have been so carefully worked out that the whole thing is done by boys.

THE MEASUREMENT OF INSULATION RESISTANCE.

Cases frequently arise in which it is necessary to determine the insulation resistance of an installation without shutting off the supply of power. Mr. E. F. Northrup describes a very simple



method which can be applied by using a sufficiently sensitive voltmeter. Suppose as shown in the diagram that the resistance to earth of each of the conductors is X_1 and X_2. Let the voltmeter have a resistance g; let the voltage of supply be found to be e; and let the voltage found by connecting the conductors respectively and successively to earth be V_1 and V_2. Then it can be shown that

$$X_1 = g\left(\frac{E - V_1}{V_2} - 1\right)$$

and $$X_2 = g\left(\frac{E - V_2}{V_1} - 1\right)$$

In the case of a large building, the following figures were found, viz., $g = 12,220$ ohms; $e = 113$ volts; $V_1 = 1$ volt; $V_2 = 4$ volts. Whence $X_1 = 329,940$ ohms; $X_2 = 1,310,760$ ohms. Of course the method fails if it is impossible to read V_1 or V_2 with sufficient accuracy. In which case, galvanometer methods must be employed.

ELECTRIC LIGHTING IN WEAVING SHEDS.

The majority of cotton-mill owners in Great Britain have been slow to take advantage of electricity as an illuminant for their weaving sheds, and, in fact, for their entire cotton establishments. Possessed as they are of mechanical power in the shape of large engines operating line shafting, they can laugh at the high prices asked by any local supply authority, seeing that a dynamo driven off the line shafting will adequately meet their needs at a cost considerably lower than that paid by local tradesmen for their lighting. The dynamo so driven does not represent the *beau ideal* for such a purpose, but mill-owners must first be "little piggers" before becoming "whole hoggers," and in their wisdom instal the belt-driven rather than the direct-coupled set. Much has been written comparing electric and gas lighting under various conditions, but so far we have seen no more comprehensive statement than that contributed in a lengthy serial to the columns of our contemporary, the *Practical Engineer*, and recently concluded. The author, who for some reasons prefers to remain anonymous, remarks at the outset on the impurity of the atmosphere in most weaving sheds lighted by gas, and quotes instances in which the percentage of CO_2 has reached 29.7 per 10,000 volumes of air, the stipulations of the Act being nine volumes of CO_2 per 10,000 of air. He further remarks on the desire of the manufacturers to lower the standard to eight volumes, adding that the Home Office, in considering this wish, is likely to display a preference for electric lighting and insist on its introduction. From inquiries made by the author as to the health of employees, cost and advantages or otherwise of electric lighting where adopted in mills, typical replies were to the effect that on all points mentioned electricity had the advantage, while especially noticeable was the improved appearance of the workers and their greater ability to work. The financial results in the instances quoted were also in favour of electricity, while an additional asset was found in the increased output due to the improved health of the operatives. In preparing an estimate of the cost of an electric light installation, the author took as a basis one 16 c.p. lamp per two looms or two 8 c.p. lamps per loom., and for a total of 1,200 looms, including offices, preparing rooms, &c., 1,000 lamps would be required. These represented in round figures 100 h.p., which if used for 500 hours per annum—a fair average figure—amounted to 50,000 h.p. hours. Considering the estimate further the matter of a "pilot" set as compared with either gas-jets or a battery

for supplying light when needed - after stopping or before starting the engine was discussed, and decided upon as the best solution of the difficulty. After much lengthy matter on batteries and the elements of electrical units, the estimate appeared as follows:

	£	s.	d.
60 k.w. dynamo d/d and fixed .	300	0	0
12 k.w. steam dynamo (pilot) .	200	0	0
Switchboard	75	0	0
1,000 lights at 17*s.* 6*d.* per point	875	0	0
	£1,450	0	0

On the annual cost of working figures, several items were considered and tabulated thus:

	£	s.	d.
70 tons of coal. 10*s.* . .	35	0	0
Lamp renewals . . .	25	0	0
Interest 10 per cent. on £1,450	145	0	0
Depreciation do. do. .	145	0	0
Insurance, Inspection, &c.	10	0	0
	£350	0	0

Against this the cost for gas lighting was set, and with 5 c.f. burners, 1,000 burners burning 500 hours per annum, 2,500,000 c.f. or 2,500 thousand feet would be needed, which at 3*s.* per 1,000 would cost £375. To this, however, the sum of £50 must be added to cover renewals of burners and interest and depreciation of plant. The total for gas lighting, therefore, amounted to £425 per annum, which compared with electric lighting showed a balance favouring the latter of £65 per annum. As the author remarks, the figures for electricity are excessive, but even with this the balance is in its favour. Further, the gas figures are deduced to be lower than those usually obtaining under such conditions.

ELECTRIC LIGHTING IN THE ARGENTINE AND URUGUAY REPUBLICS.

THE extremely rapid growth of the electrical industry in this part of the world calls for the present description, as we have here a wide field for electrical enterprise, but for this we require capital and men with technical knowledge, and these will not come from the native financier or native student. The first efforts made in electric lighting in the Argentine were by the Edison Company in 1881, when a representative of Messrs. Fabri and Chauncy took out the Edison patents, first in Santiago, Chili, where two electric light stations were constructed, but owing to the heavy expenses and lack of competent electricians the company had to cease working. After this they came to the River Plate and obtained the patents for an electric light station, it being one of the requirements of the Argentine patent law that everything patented in the country must be shown in working order within a certain period. The plant was subsequently installed in a confectionery shop in Buenos Aires, and simultaneously a similar plant was installed in the Uruguay Republic in Fray Bentos. To revalidate the patents in that country, the representative of the Edison Company then went to Rio de Janeiro for a similar object, but he unfortunately died, thus putting for the time a complete stop to the Edison Company's work in South America. About 1882 a representative of the Brush Electric Company of the United States of America came to the Argentina and intended to try to obtain the concession for public lighting for the city of Buenos Aires. The municipality, however, would not grant the concession, owing to the influence of the powerful gas companies, but after two years' hard work permission was obtained from the Mayor of the city to carry out a series of experiments, and the Brush Electric Company established a small plant, and for several months the principal street called Florida was lighted up by arc lamps. This installation, however, was not a success, and it did not find favour with the public, more especially with the Argentine ladies, who complained that the electric light made them look too white. There being no opening for electric light at that time, the Brush Company's plant was shut down.

Early in 1887 the Central Argentine Railway Company erected at their Rosario Station a private plant, the first of its class in the Argentina and the most successful. The plant consisted of the following machinery:

Two 12 h.p. nominal Marshall and Sons compound stationary engines and boilers, three Crompton dynamos, 30 amp. 300 volts direct current for arc lighting, one Crompton dynamo, 60 amp. 110 volts for incandescent lighting.

In 1892 two 30-h.p. Robey compound engines and boilers took the place of the former engines, and the dynamos in use to-day are three arc dynamos 45 amp. 300 volts, and three incandescent 109 amp. 110 volts. There are now twenty-five arc lamps of 15 amp. and 500 incandescent lamps of 16 c.p.

With respect to the city of Buenos Aires, after a lapse of four years Mr. C. V. Boisot came to the Argentina as the representative for the Edison Company and succeeded in forming a local company, besides carrying out an installation in the Colon Theatre in Buenos Aires, and one in the fashionable watering-place Mar del Plata; he also established the electric light at Adrogue, near the city of Buenos Aires, and a permanent plant was then erected in the city consisting of a 12-h.p. engine and a Gramme dynamo. The system was low tension with two wire distributions and the output was

about one hundred incandescent lamps of 16 c.p. In 1890 the Edison Company commenced the installation of an electric light station, using the three-wire system with underground mains. This plant was erected in the centre of the city, which is to-day owned by the Primitiva Gas Co., and a branch of "Allgemeine Electricitaets Gesellschaft of Berlin" called the "Cia. Alemana Transatlantica de Electricidad." The Edison Company went under after a short time of hard work and difficulties, before the station was completed. From 1891 to 1894 very little progress was made in electricity, but in the latter year the first high-tension alternating plant was established by the municipality and on account of the destruction by fire of two theatres in the city of Buenos Aires the municipality decreed that all the theatres must in future be illuminated by electric light. To meet this decree a plant was erected in the Opera House, and current was supplied to eight theatres. Until the year 1896 the Calle Florida was the only street lighted by arc lamps, or in fact by any system of electric light.

The following short history of the public lighting of the city of Buenos Aires will be of interest. The first record that we have of the introduction of public lighting in Buenos Aires, and therefore the first in the Argentina, was during the viceroyalty of Juan Jose de Vertiz, who in 1794 decreed that the streets be lighted during the dark hours of the night. The first lighting was done by means of tallow candles, placed in lanterns, and after several years oil lamps took the place of the candles, which in their turn were substituted by gas in 1855, and in 1890 some streets were first lighted by electricity. To-day the city of Buenos Aires is lighted by means of 890 arc lamps, 14,000 gas and 8,540 kerosene lamps, at a total cost of $134,000 per month. The public arc lighting was formerly done by three companies, two by direct current with two lamps and more across the outers, according to voltage, and the others by alternating current with a step-down transformer to each lamp, placed across the outer and middle wire of the system. This is now done by the Allgemeine Company.

There are, according to the national census returns, thirty-four stations in the Argentine Republic with an approximate capital of £2,500,000 and an output of about 25,000 h.p. Twenty-four stations are direct current and ten alternating current. Outside of the aforesaid public stations there are also about 450 private plants in the various industrial concerns throughout the country. With the exception of the city of Buenos Aires and Rosario, all the electric light mains are located overhead. The total length of underground mains is not far short of 930 miles.

ELECTRIC LIGHTING NOTES.

H.M.S. "Buzzard."

THE Charing Cross and Strand Company has just added to its list of consumers one of a somewhat unusual character. H.M.S. *Buzzard*, which is now moored off Temple Pier to serve as training-ship for London's naval volunteers, has been fitted with electric light, and arrangements have been made with the Charing Cross and Strand Company for the supply of current by a submerged cable from the Embankment.

The Osmium Lamp.

THE manufacture of this lamp is described in *Electricity*, New York, by Mr. T. Commerford Martin, and seems to be conducted on lines somewhat similar to that of flashing incandescent lamp filaments. A filament consisting of an osmium-platinum alloy is made by running a thin platinum wire in a vapour, which consists of a mixture of hydrocarbons, water vapour, and perosmic acid vapour. The result is that osmium is deposited on the wire. The platinum core is afterwards volatilised at a higher temperature, leaving a tube consisting of osmium and platinum alloyed together. Apparently another process consists in squirting a mixture of finely divided osmium, held together by a binding material. This is converted into a wire of osmium by subjecting it to the temperature of the electric furnace, and thus removing the binding material, and welding together the osmium particles. This welding can only be carried to a certain point, seeing that wires which are too dense and not slightly porous, are more liable to fracture. It is also said that osmium-carbon filaments can be made, as well as those containing thoria and zirconia. Still all this has at present too much of the appearance of experimental work. It is well known that all these things are possible in the laboratory; but this does not mean that the products are commercial possibilities.

The Blondel Arc Lamp.

THIS lamp differs essentially in construction from the old type. The negative carbon is uppermost, and consists almost entirely of carbon. The lower electrode, generally of slightly greater diameter, is a composite carbon. The outer zone is of carbon; the next layer is a mixture of carbon, and various salts, such as those of calcium and magnesium. The innermost layer is of similar composition, but is subjected to a smaller pressure, and has the function of steadying the burning of the arc and maintaining it in a central position. Around the upper electrode and just above the arc, a reflector is arranged, which soon becomes, coated with white oxides. It therefore acts as a condenser of any fumes that may be given off and makes the lamp suitable for inside lighting. Dr. Wedding reports that the economy of this form of lamp is nearly as great as that of the Bremer light, and that it has the very important advantage of giving this high efficiency at a much lower current density. Thus in the Bremer lamp an efficiency of 0.1 watt per c.p. is obtained with a current of 28.6 amperes, whereas with 5.1 amperes in the Blondel lamp the consumption works out at 0.109 watts per c.p.

For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section at end of Magazine.

The New Portland Automatic Telephone Exchange.

By FRANK C. PERKINS.

THE accompanying illustrations, Figs. 1 and 2, show the automatic switchboards and electrical equipment of the Northeastern Telephone Company's new exchange recently installed at Portland, Maine, and the Vice-President and General Manager, Mr. Louis A. Goudy, reports most favourably upon the Secret Service Phone installed in that city. The first floor is utilised for the business offices, long-distance telephone booths, and reception rooms. The storage battery room, testing-room, and distributing-racks are located on the second floor, with space for an equipment for 8,000 subscribers, or a sufficient area for 3,000 subscribers in excess of the 5,000 accommodated on the third floor. the third or top floor is equipped with racks to accommodate 3,000 switches or Secret Service telephone connections, with 2,500 already installed for immediate connection, and surplus room for 2,500 more, making a capacity of 5,000 subscribers. The automatic exchange building of the Northeastern Telephone Company has a total floor-space of 10,000 ft., with a ground-area of nearly 4,000 ft. The switchboard noted in the illustration includes three tiers of ten boards in each tier, each of which represents 10,000 subscribers. Additional shelves with twenty-five switches on each shelf may be added to increase the exchange for a much larger number of subscribers.

The power installation of this automatic exchange is provided in duplicate, two sets of storage batteries being employed each consisting of a series of twenty-six cells. One set has a capacity of 200 ampere hours and the other an output of 300 ampere hours, the elements of the accumulators being supported on a stand and insulated with porcelain knobs. The charging machines are of the General Electric type, with a pressure of 75 volts, directly driven by a 60 cycle two-phase alternating-current motor. One of the ringing outfits consists of a two-phase 60 cycle motor directly coupled to a Holtzer-Cabot ringing-machine, the current being supplied from the local power-circuit, while the other ringing set consists of a motor-generator driven by current from the storage battery plant.

A telephone system was installed in the city of Portland more than two decades ago, the Dirigo Telephone Company of Maine claiming to be one of the oldest, if not the oldest, independent telephone company in America. Two years ago the Northeastern Telephone Company was organised, and it now has in operation nearly 200 miles of trunk line, connecting nearly four score of cities, towns, and villages in North-

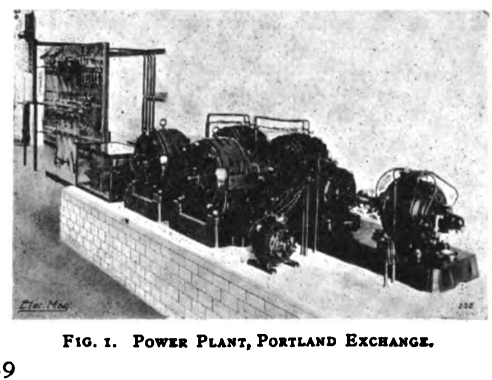


FIG. 1. POWER PLANT, PORTLAND EXCHANGE.

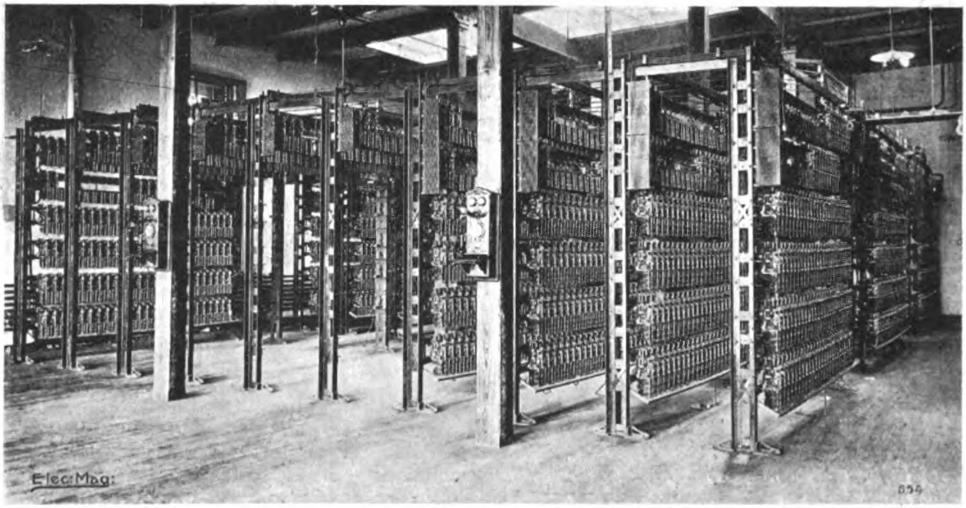
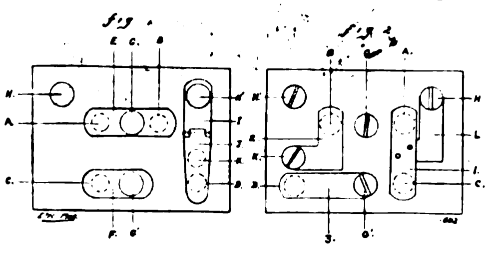


FIG. 2. INTERIOR OF PORTLAND AUTOMATIC EXCHANGE.

western Maine with nearly 100 pay-stations and at least a dozen exchanges, in addition to the automatic exchange at Portland. This system is claimed to be absolutely automatic and secret as carried on along the 7,000 miles of wires, with their rural line connections. The automatic switches are mounted on iron racks of ten to a section, each containing 100 switches, or a total of 1,000 switches to each section. The exchange building cost about £8,000, exclusive of its automatic switchboard and equipment. A total of nearly half a million dollars has been spent in Portland during the past year by the North-eastern Telephone Company. The conduit and underground cable construction extends through about eleven miles of the streets with between 300,000 and 350,000 ft. of duct, and more than 7,000 miles of cable and aerial wire has been installed in Portland alone.

A HEAT COIL TESTER.

THIS little instrument was devised for testing the continuity and resistance of heat coils after having been repaired, without the necessity of using a Wheatstone bridge. It will be seen that the arrangement is very simple, Figs. 1



and 2 being front and back views of the instrument.

The device comprises an ebonite base, the dimensions of which are $3\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{3}{4}''$, holes being drilled through at A, B, C and D just large enough to permit a heat coil to fit easily. Two brass plates, E and F, are fitted to the top of the base and secured by terminal head-bolts, G, G¹. A similar bolt is also fixed at H. I is a brass block having a hinged key, J, fitted to it. This block is also secured by a terminal head-bolt, H′.

A small brass stud is fixed at K, which forms a connection with a spring fixed to the under-side of the key, K, when the key is depressed. To ensure good contact at the hinge of key K, a small spring is fixed under the block at I, which extends beyond the hinge, and which comes into contact with the key when depressed. The bottom of the ebonite base, Fig. 2, is undercut, as shown by the shape of the brass block L, and the brass springs 1, 2, and 3, so as to make them flush with the bottom. The brass block L is in metallic connection with terminal head-bolt H, the brass spring I being fixed to this block, the spring is intended to press the heat coils inserted at holes A and C into contact with brass plates E and F. Spring 2 is secured by the stud K, and extends to hole B to press heat coil inserted at B into contact with plate E. Spring 3 is in metallic connection with plate F and extends to hole D, in which the heat coil to be tested is placed. It will be seen from the foregoing that should three heat coils, which are known to be good, be placed in the ebonite base at A, B, and C heat coils in A and B will form arms as in a bridge, the one in C being the measure

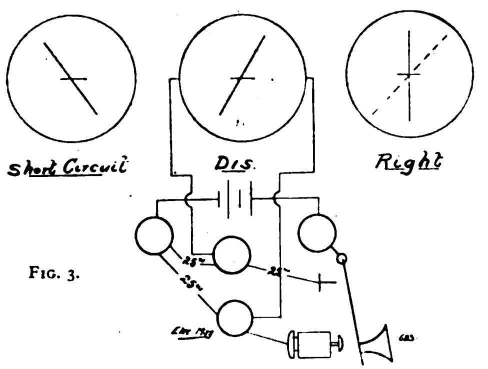
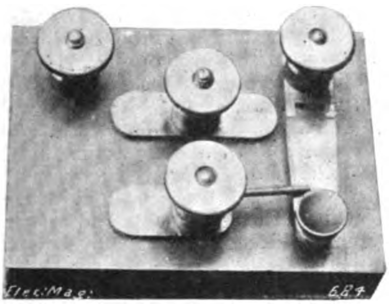


FIG. 3.

of the coil to be tested. Should a heat coil be placed in the hole D and the key J be depressed so that it comes into contact with the coil, a circuit would be formed through the coils for the current from the battery. (*See* theory diagram, Fig. 3".) Key J is hinged to permit of easy access to hole D for placing in and withdrawing the coils under test. A momentary deflection on the galvanometer would be observed on



VIEW OF HEAT COIL TESTER.

depressing key J; this is because the spring fixed to the underside of it comes into contact with the stud K before reaching the coil to be tested.

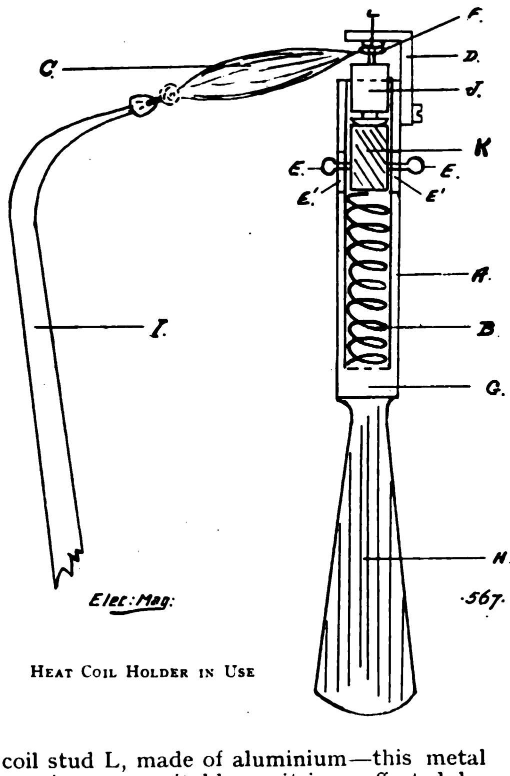
It would, however, return to zero should the coil be right. This momentary deflection is useful in proving the connections to battery and galvanometer to be good. Should the coil be disconnected, the deflection would remain. If the coil should be short-circuited, a deflection in the opposite direction would be given. In combination with a battery and a galvanometer of about 100 ohms, the device proves to be a useful tool, in the absence of more elaborate apparatus, the coils being easily changed for those of different values if necessary. M. G. W.

A USEFUL HEAT COIL HOLDER.

MR. M. G. WAGGOTT has furnished the following:

This little tool was designed with a view to the quick repair of heat-coils after having been operated by an excess of current. In practice it is found to answer the purpose very well, and is in every way an improvement on the old method of using a soldering-iron. The sketch, which is drawn partly to section, gives all the details.

A is a piece of brass tube the internal diameter of which is just sufficient to admit the heat-coil J. B is a spiral spring to press up the heat-coil J, which rests on piston K. When heat is applied to the heat-coil stud L, as shown in the sketch at C, by blow-pipe I, and gas-jet, the stud L is automatically pressed home. To facilitate the placing in and removal of the heat-coil, the L-shaped piece D, also of brass, is movable, so that it can be drawn back by slightly relieving the pressure of the spiral spring B, by the two studs provided at E E, fixed to the piston K for this purpose. It will be noticed that the brass tube A is slotted at E E' to permit of such a movement. F is a guide for the heat-



HEAT COIL HOLDER IN USE

coil stud L, made of aluminium—this metal proving very suitable, as it is unaffected by the fused solder. It will be seen that the tube A is cut away at this point to permit the flame being applied direct to the stud L. G is a piece of solid metal fixed into the tube A to support the handle H, which can be made of wood or any suitable material.

Telegraphs in Ceylon.

By E. O. WALKER, C.I.E., M.I.E.E.

OWING to the fact that the mail steamers and transports, from the time of the British occupation of Ceylon, used to call at the port of Galle, telegraphic communication between that port and Bombay and Calcutta (when the telegraph became practicable) was rendered very necessary. One of the early cables in the Straits of Mannár was laid by an intrepid Superintendent of Telegraphs from Madras by sailing across from shore to shore. The newer cables, of which there are two, were laid by a steamer of light draught. The cables are of gutta-percha, overwound with brass tape, and armoured in the usual way. The tape has been found to protect the gutta against marine borers. The waters of the Straits were comparatively shallow and warm, and accidents have at times occurred to the cables which in deep seas would have been obviated. A few years ago both cables were interrupted and communication was maintained between Mannár and Paumben, through the faulty sections of cable and land-line with Cardew's vibrating-sounders. Several hundred messages were daily carried by this means. When the harbour at Colombo was completed fifteen years ago trade left Galle, and the commercial importance of the former town became considerable. It is not an unusual sight to see a dozen large steamers, besides warships and numbers of native sailing craft, laying at moorings within the harbour-arms. Telegraphic traffic has, with growing exports and imports, enormously increased. Besides mercantile intelligence, it is also largely composed of domestic telegrams, to which the Cingalese are much addicted, as well as of money orders which are used for remittances by the Tamil coolies from Southern India who work in the gardens. The internal telegram is a cheap one, about fourpence in English money. The rate to India is moderate, and that to Europe about half a crown a word. Every little station where there is a cluster of Englishmen, or more than a thousand or so of natives, claims a telegraph office, and a liberal interpretation of the people's wants has led to the wire penetrating to remote corners of the jungles. Leaving the terminus of the cable on the island of Mannár, the line passes through groves of palmyra-trees, which seem to flourish in the sandy tracts, across the channel and port, to the main island, alongside of the enormous and now decayed reservoir known as the Giant's Tank, centuries ago the mainstay of irrigation in these parts. Through the bush and scrub of the Wanni, and on to the forest shades of Anúrádhapúra, the wonderful Buddhist city, now in ruins, past the rock temple of Dambula, on to beautiful Kandy, a gem of loveliness nestling amid tree-clad mountains ever verdant, and so on to Colombo by the railway, cut in many places out of the precipitous slopes. There are some pretty pieces of construction work in connection with the mountain lines. Spans often stretch beyond the limit of sight, although the cutting through the forest indicates the route taken by the wire. The supports used, which are frequently that of Siemens' pattern, seem too slender for the strain put upon them in the monsoon storms on the exposed peaks, but many have stood unharmed for twenty years. The distance from post to post must be sometimes half a mile, the wire hanging over the tops of lofty trees in the ravines below, and yet even in gales there is seldom breakdown to the lines in these isolated positions. In the cocoa-nut groves of the coast the experience is different, for the leaves are constantly falling with great force, and in storms whole trees come down, so that the wires are apt to be mixed up and broken from both causes. The present extent of the lines is 1479, and of the wires 2853, miles. A large number of the poles in use, are cut in the forests of Ceylon, among which is the satinwood which takes so beautiful a polish, and, from its texture, is in demand for cabinet work. This is one of the most durable woods, and such poles have stood for over thirty years with no artificial preservation. Iron wire lasts well in the interior of the island, but not so on the coasts, and here bronze is a good deal employed. Many forms of insulators have been tried, with the view to finding that most suitable for so rainy a climate, and so saturated an atmosphere, as prevail, and none have proved so good as the one now adopted, the British Post Office, or Cordeaux pattern, in plain white porcelain, with double cup, screwed on to the spindle in accordance with modern practice. Some of the inferior stoneware cups have been found to break spontaneously from changes in temperature. White ants are very destructive to soft-timber poles, but after eating away the soft parts, the more resistant wood is often left alone and remains good for years. In the secluded parts of the forests the lines are sometimes damaged by wild elephants, which also stop the traffic on the roads, and delay repairs by the linesmen. The latter do not relish a solitary march on line inspection, partly for fear of elephants and bears, and partly on account of the evil spirits, which are always about, especially before sunrise and after nightfall, and the society of a coolie is found to be a great comfort.

Most of the offices in Ceylon are combined for postal and telegraphic work, and are carried on at moderate expense. Duplex working is availed of between Madras and Colombo, and on lines within the island, and Wheatstone's Automatic System has been used on an emergency between the latter place and Kandy. For the most part other circuits are equipped with relays and sounders. The difficulties of maintaining good communication in a climate so trying and in a country so full of large trees and subject to so much lightning are great, but much success has been achieved by the present Superintendent of Telegraphs, Mr. Montagu, and his assistants, who have been assiduously at work for years past eliminating weak spots and installing wires by alternative routes. The railway telegraphs are under the same management, and demand much time and attention, a great part of the line being on the mountain inclines. The highest point reached is about seven thousand feet above sea-level. The signals are manually operated, and the stations are equipped with ordinary sounders and keys, which serve for despatch of trains and traffic orders. Near Colombo the Tyers Tablet System is in use on the sea-side line for regulating the movements of trains.

The telephone, introduced into Ceylon by the Oriental Telephone Company, became a Government service seven or eight years ago. There is an Exchange in Colombo, embracing about a couple of hundred lines, worked on overhead metallic circuits, with a multiple board made by the Western Electric Company. A few telephones are in use on private lines on tea estates, and there are some employed for official purposes at outlying stations. Labour is cheap, and the telephone will in time, no doubt, be brought within the reach of many who do not care to pay the present rates. There is no demand for trunk lines.

The trade of the island is increasing fast, and will call for further telegraphic development, and the installation, no doubt, of a wireless system for communication with vessels entering and clearing from Colombo, as well as those passing the signal-stations.

THE SUPERSESSION OF THE TELEGRAPH BY THE TELEPHONE, AND OTHER CAUSES OF ITS DECLINE.

We have referred lately to the decline, in some European countries, of the telegraph, in competition with the telephone. The *Telegraph Age*, of New York, makes some observations bearing upon the same point, and cites other causes which have tended to reduce telegraph traffics in that country. We refer to the changing conditions of business, resulting frequently in the union of competing interests, heretofore separate and extensive users of the telegraph, into vast industrial combinations. Here is encountered another and serious curtailing element to telegraphic well-being. The telegraph has felt the check inflicted by the economic measures which such coalitions are designed to produce. It may be instanced that since the iron industry passed within the control of but comparatively few people, telegraphic receipts from that source alone have fallen off largely in amount. The same thing is also substantially true in the wholesale dry goods trade and in the sugar refining industry. One of the first moves made by the steamship combine, recently brought about, was to reduce in amount the sum set apart for telegraph tolls by at least $50,000 a year. This change was so sweeping in its character as to abolish the special telegraph department and cause the dismissal of the operating staff which had been maintained for years.

Even the poolrooms, which were cut off from the Western Union Telegraph Company's service recently, were constantly engaged in devising combinations whereby telegraph tolls might be saved. Then, again, the increased expenses of operation due to a number of causes, such as heavy and increasing tax exactions on the part of States, counties, and municipalities, oftentimes unjustly enacted, damage claims, costs of rights of way, &c., all unite to make the successful doing of business on the part of the telegraph companies more and more beset with difficulties, requiring the utmost care and the practice of close economy on the part of those entrusted with the administration of these great properties.

TELEGRAPH NOTES.

Abyssinian Telegraphs.

The first wire between Harra and Addio-Adeba was erected in 1898. It was 550 kilometres in length. A second was put up in 1900. The idea of working them simultaneously for telegraphy and telephony was at first favoured, and the plan was tried, but proved unsuccessful. At present the wires are used alternately for the two systems.

The New Gutta-Percha.

The behaviour of this compound is being watched with much interest. The German Government has been experimenting with it since the year 1902. On the coast a cable insulated with the material and containing four conductors each 24 kilometres long continues to give satisfaction. The insulation resistance is 500 megohms and capacity 0.5 microfarad per kilometre.

One of the Longest Telegraph Circuits in the World.

The Indo-European Telegraph Company has provided a through wire from Manchester to

Teheran, which is worked by automatic relay translation. The length is 6400 kilometres. This result has been achieved after forty years of laborious work in building up an efficient system, in the face of great physical obstacles, and the Company stands to-day a monument of genius and enterprise. Political difficulties have never deranged the working of this wonderful circuit.

Diminishing Rubber Product.

WITH an ever-increasing use of rubber in manufacturing, particularly in all electrical industries, where it is largely used for insulation purposes, it is disappointing to have to record a gradual diminution in the supply. Some figures have been published purporting to show the total production of rubber in different parts of the world, and according to these the production in the two years from 1900 to 1902 decreased by some 3,500 tons; that is to say, whereas the total output in 1900 was 57,500 tons, that in 1902 was only 54,000 tons. This decrease is certainly not a large one, but it is important as showing the tendency of the rubber supply to diminish. It is very instructive to examine, the *Scientific American* says, the figures given for the different countries. Our two main sources of supply are Brazil, Peru and Bolivia, and East and West Africa and the Congo country. From the first group the total supply in 1900 was 25,000 tons, and from the second 24,000 tons, but whereas in the former case the production has increased, it has appreciably decreased in the case of the latter. Thus, Brazil, Peru and Bolivia contributed 30,000 tons to the world's supply in 1902, as against 20,000 tons for East and West Africa and the Congo country. A small supply is now had from the Straits Settlements, but in 1902 the output was only 1,000 tons. In every other case the production shows a decrease. The various States of South America gave 3,500 tons in 1900 and 1,000 tons in 1902. Central America and Mexico gave 2,500 tons and 2,000 tons respectively; Java, Borneo, &c., 1,000 tons in 1900 and nothing in 1902, and similarly the supplies from Madagascar and Mauritius, and India, Burma and Ceylon have ceased altogether. Thus, of the total supply of 54,000 tons in 1902 as much as 50,000 tons came from Brazil, Peru and Bolivia, and East and West Africa and the Congo country, which remain the world's chief sources of supply. India and Ceylon are, however, planting rubber.

Telegraphs at the St. Louis Exhibition.

THESE are located in the Electricity Building. The Western Union Telegraph Company, as well as the Postal Telegraph-Cable Company, have offices and exhibits in this structure, besides regular offices located in various sections of the grounds available to all who desire to use the wires. Among these exhibits referred to are: The Delany Automatic Telegraph System has a fine working exhibit. Mr. Patrick B. Delany, the inventor, is in attendance at the exhibit and will personally explain the details of the system to all callers. The Phillips System of Telegraphy also occupies suitable space near the telegraph offices. Mr. Charles E. Yetman has installed a working exhibit of the transmitting typewriter. It will be found in Section 1, at the north-west end of the building. A telegraph pole has been erected at one corner and wires strung overhead about the space, with drops connecting up the various machines, so that sending and receiving with the "Yetman" may be visibly and audibly demonstrated, making a unique and realistic exhibit. The wall decorations are tan-coloured burlap, the furniture golden oak with brass rail in front, making an attractive and artistic display Experienced operators will be in constant attendance to explain the machine, its mechanism and working, to all interested. The Standard Underground Cable Company, in conjunction with the McRoy Clay Works, have a joint exhibit in Section 3, immediately adjoining the north-west entrance. The exhibit shows a cross-section of an actual conduit consisting of 72 ducts with a manhole at either end, one manhole being complete with a cover, the other being open. A trench, 7ft. deep and 5ft. wide, extends the entire length of this conduit, enabling close inspection of the method of laying conduits, including the wrapping, concrete base and top, and the general construction of the manholes, showing hangers, pipes to poles, &c. At one end in the manhole is shown a capstan rigged up for drawing in cables and connected to a cable which is mounted on a reel at the other manhole; the cable being drawn through the ducts and part of the ducts being split so as to show the method of fastening cables to rope, &c. From the manholes, cables go to distributing poles, showing the method of distribution to aerial cables for telephone, electric light and street railway work with various terminals used to protect the ends of the cable in such work. The company also shows samples in handsome cases of all the various cables and appliances made by them. An examination of this system will show, in very complete detail, the method of installing conduits and drawing cables into completed conduits.

Wireless Telegraphy.

The Wireless Licensing Question.

By L. H. WALTER, M.A., A.M.I.C.E.

FROM the Government's new Bill on the subject, it appears that wireless telegraphy is giving rise to anxiety in the minds of other and less autocratic governments than Russia, and now both in the United States and in Great Britain the authorities have seemingly awakened simultaneously and come to the conclusion that wireless telegraphy must be controlled; there must be legislature, and perhaps monopoly. For the purpose of discussing the subject, it is necessary to look at the matter from the different points of view. First there is the natural feeling, as a result more especially of the Russo-Japanese War, that in case of hostilities such a valuable means of communication should be directly under control of the authorities, and, further, that the number of existing stations should be known. Secondly, there is the public

good, and as regards this it is obvious that anything which conduces to regularity and efficiency must tend to the general advantage. Thirdly, there is the case of the wireless telegraph companies, who in many instances have had to spend their money, and that freely, in their endeavour to build up, if not a monopoly, at any rate an equal chance of a share of the business.

In examining the case for the respective Governments, there is a good deal to be said in favour of their contention that control is required, as the example furnished by the wireless station at Chifoo, which was erected in the grounds of the Russian consulate there, serves to show how much mischief a single station can do so long as its presence is unsuspected or unknown. As regards the United States, which possesses so extensive a coast-line that supervision is quite impossible, it would appear to be a very wise step to have all coast stations at least under control, and although the same applies to some extent to Great Britain the desire for legislation here reveals another less obvious cause—this is the helplessness which it implies to a certain extent, the greater perhaps owing to the comparatively small size of the British Isles. It is true that the limitations of wireless telegraphy have always been frankly acknowledged by disinterested people cognisant of the subject, and it is for that very reason all the more obvious that the authorities must now be fully convinced that these limitations are inherent and to some extent ineradicable—in fact, that they feel that at present at any rate secrecy is a myth as far from realisation as ever. So now after all these years we come back to the state which it was pointed out would occur, when in the infancy of the subject it was said that as soon as the ether began to get full up with signals, the stations would have to be controlled (and amicably adjusted so as not to disturb one another).

As regards the public good, it is impossible to quite foresee how events will turn out in the United States, but here it is more than probable that the Bill will prove to be the thin end of the wedge of Post Office monopoly. This may be no bad thing for the public, as there are still a number of more or less inaccessible places which could be conveniently connected (if the term can be used) by wireless. The Post Office itself seems to be emulating the doubtless interesting but rather unprofitable method which has produced so much chaos already in the United States. It is experimenting in devising a pet system of its own. Over there each department almost has a system of its own, at least the Navy, the Army, the Weather Bureau, and the Department of Agriculture have, and each of course is free to adopt any outside apparatus to its own special system and to introduce it free of duty if it is of foreign origin. This it is said has already been done, but then the systems are not for public use.

The wireless telegraph companies themselves have probably the most to fear from legislation and Governmental control, and it is probable that there will be some dissatisfaction in that quarter. That more stringent tests may be required from a company wishing to do business is very probable, but one thing is quite certain, and that is that such disgraceful methods as trying to render messages unreadable and otherwise interfering with rival stations will be quite impossible, as such practices would only result in the offender's licence being withdrawn, and the removal of the possibility of any such annoyance will certainly be welcomed by all companies which have a system the merits or demerits of which do not fear the daylight.

WIRELESS TELEGRAPHY NOTES.

New Wave Receiver for Wireless.

THIS instrument has recently been devised by M. N. Vasilesco Karpen. Between two vertical and cylindrical armatures, connected by circuits of suitable self-induction, a needle is suspended composed of two cylindrical metal-joined parts of thin aluminium. One terminal of the instrument is earthed, and the other taken to the antenna. When waves strike the latter, the terminals are subjected to an alternating P.D. of the same periodicity as these, and the needle rotates so as to increase the capacity of the system. The deflection is amplified by a mirror fixed to the needle, which may be prevented from taking an accidental charge by being connected to the middle of the circuit. The most favourable conditions obtain when the self induction of this circuit and the capacity of the system to which an auxiliary capacity may be added, satisfy the condition for resonance As is well known, coherers and magnetic detectors are specially sensitive to the shock of the front of the impinging waves, whereas this instrument totalises the effects and measures the energy received by the antenna. The system could be of service probably for long-distance messages, for distance does not appear to be limited by the sensibility of the detector, but by the impossibility of making it insensible to extraneous influences. A mean sensibility has therefore to be adopted, and to compensate this, the energy of transmission must be increased. This depends on two factors (1) the amplitude of the waves (2) the frequency of waves per signal. In ordinary detector the first factor alone intervenes, whereas with the above instrument the number of trains of waves in a message can be profitably increased.

Wireless Synchronising of Clocks.

IN a recent issue of the *C. Rendus*, M. Bigourdan sets forth a scheme for synchronising publ c clocks by wireless. In Paris there are a number of clocks in the various districts which are electrically connected to the Observatory, a

very commendable system, but which cannot be used to an unlimited extent, and further involves the expense and trouble of laying down and connecting many conductors. In the author's experimental apparatus, one central or directing clock breaks a contact each second, operating a relay which in its turn sends a current through the primary of an induction-coil, provided with an oscillator, the induced current thus supplying every second a discharge of very small duration. The two terminals of the thin wire coil are respectively connected to earth and to an antenna several metres high, by means of which the sparks act on a wave receiver placed at a distance. Two different types of receivers were experimented, the simpler being a radio-telephone of the Popoff-Ducretet pattern, in which the transmitted beats were distinctly perceived. The other was a recording receiver, or rather an ordinary wireless receiving station. To make the signals clearer, a tape chronograph unrolling about 1 cm. of tape per sec. was substituted for the ordinary Morse receiver. An approximation of $\frac{2}{100}$ to $\frac{3}{100}$ sec. was obtained with these instruments. The trials were carried on within a radius of 2 km. from the transmitter, and the results show that this radius could be considerably extended.

A Self-Cohering Receiver.

WIRELESS telegraphy, though interesting a larger circle of readers every day, suffers from repetition to an even greater extent than radioactivity; every one describes something as new or what he thinks to be new. Mr. Van Winkle in the *Electrical World and Engineer* describes what he calls the Peters self-colouring coherer. The mere title is a work of art. If a coherer is kind enough to cohere itself no messages are needed, and interference is no dreaded evil. On looking at the paper one finds that what is meant is a self-decohering coherer or strictly a continuously tapped (here rotated) coherer. The method of rotating a coherer on its axis for continually keeping it in the sensitive condition is a very old one. Guarini certainly described it fully in 1900, but if such a continuous decoherence is required and yet not a current-actuated receiver, why keep to filings? The Lodge type of mercury coherer is far superior.

Hertzian Wave Detector.

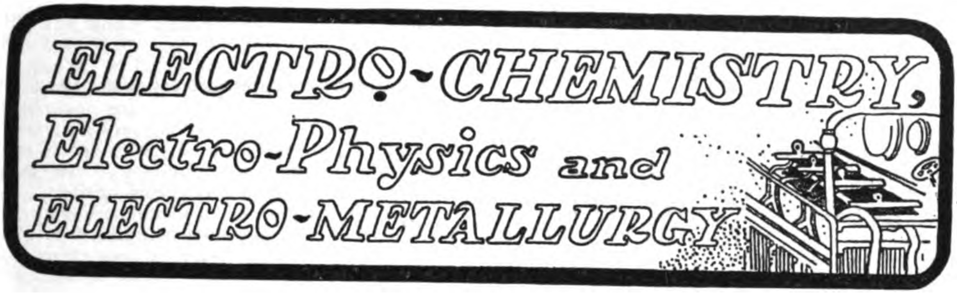
PROF. ARNÒ has written a paper on a Ferraris Field Detector of Hertzian Waves, a translation of which has recently appeared in the *Electrician*. The apparatus is based upon the principle utilised by Messrs. L. H. Walter and J. A. Ewing in their detector, which was described in our March number, though Prof. Arnò's instrument is a differential one, in which the initial hysteresis is compensated, by having two oppositely revolving fields, a device also previously used by Walter and Ewing, and described in their patent of 1902. The differential instrument is considered to be more sensitive, and while it may be so, in the form described, for physical purposes, the increase of weight due to doubling the mass of magnetic material militates against its value in wireless telegraphy, where speed is an important consideration. Much greater sensitiveness is obtained by the use of a rotating field of constant strength and the differential fields with their complications can then be dispensed with. Prof. Arnò obtains an *increase* of hysteresis in all his experiments, and consequently thinks the explanation of Walter and Ewing insufficient; but these authors and Huth consider that an increase of induction takes place when waves arrive during the reversing or mere steady application of a magnetising force; Prof. Rutherford has shown, and Signor Marconi also holds, that when the magnetising force is absent or is decreasing, a decrease of hysteresis takes place. Taken altogether, it seems more reasonable, in the absence of further experimental evidence, to consider that both effects are present in the complete cycle, especially in the alternating field, but owing to Prof. Arnò's always obtaining an increase of hysteresis, it proves that the effect discovered by Walter and Ewing exceeds that due to the Rutherford-Marconi effect. The integrated effect over the whole cycle is shown by Maurain to result in a decrease in the area of the hysteresis loop.

Wireless Telegraph Apparatus.

MR. A. FREDERICK COLLINS writes in the *Engineering Magazine* on the Metamorphosis of Wireless Telegraph Apparatus, dealing with the changes introduced owing to the experience gained in practical work. A number of the earlier forms of apparatus are illustrated, and their modern successes dealt with. Under coherers, the statement of Prof. Fessenden, that these require from 1 to 4 ergs to produce an indication is quoted, and by the arrangement adopted any non-technical reader would suppose that the Marconi magnetic detector came under this category. Prof. Fessenden's statement that his current-operated parreter works on the hot-wire principle is repeated, in spite of the fact that Dr. Reich has shown this to be an impossibility. The telephone is described as a novelty as far as its use in receiving goes, although it has been used by Dr. de Forest ever since he started, years ago. The use of the siphon recorder is then touched upon, and here again one is caused to wonder at the kind of wave detector which will produce when "the local current goes through the wave detector" a "swing of the suspended coil in either direction according to the strength of the current impressed upon it." This is too much even for the lay reader, as it is well known that in wireless telegraphy the recorder is made to give shorts or longs, but both in the *same* direction. Further, the telephone is said to have two characteristic sounds, first when the current is made, and second when it is broken. This is equally inaccurate, as it is the sudden *change* in current which causes the sound. These examples are merely pointed out to show how, in a paper supposed to appeal to technical men, a host of inaccuracies are included and even a misconception of the actual principles could be drawn by the reader from the paper of a reputed expert.

WIRELESS WAVES.

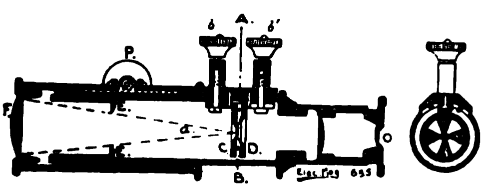
THE following is the latest up-to-date wireless telegraphy, according to the *Daily Mail*: "Mr. Marconi's experiments during his Atlantic voyage have resulted in the devising of a new form of coherer (?) in which the clicking signals of a magnetic receiver are heard through a telephone." Comment is needless.



Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section at end of Magazine.

FÉRY PYROMETRIC TELESCOPE.

THE want of an apparatus for measuring high temperatures is being keenly felt in several industries, as few of the many pyrometers recently put forward have survived the test of practice. M. Féry has just invented a pyrometric telescope based on a law discovered by Stéfan which governs the calorific radiations of hot bodies. The quantity of heat radiated by any black body is, according to this law, proportional to the fourth power of the absolute temperature of the body. A black body may be defined as one which, when heated in the open, radiates after the manner of Kirchoff's enclosed space, that is, a very large-sized furnace radiating through a small aperture. Amongst black bodies may be classed coal and the majority of the *white* oxides of platinum. Now it has been established that inside a furnace all bodies behave like black bodies and consequently follow Stéfan's law; a method can thus be found for measuring their absolute temperature. Féry's telescope has an object glass of fluor-spar, which is transparent to all radiations. The hair-lines are too narrow strips of iron and constantan welded at their juncture, and forming a thermo-electric couple; their extremities are fixed to two brass disks C and D connected to terminals b and b'. The object of this disposition is to eliminate the effect of parasitic radiations emanating from the sides of the telescope, as they are thus made to heat the thermopile without introducing any perturbation. The diaphragm E is placed at a fixed distance from the reticle in order to make the readings independent of the distance of the source of radiations under experiment. Two flexible wires fixed to terminals b and b', and whose resistance does not vary with temperature, connect the telescope to a special low resistance (10 ohms) galvanometer of the d'Arsonval type, giving a deflection of 1 mm. with .0000004 volts terminal P.D. The mirror is at 1 metre from the scale. For industrial purposes a quadrant galvanometer is used, standardised with the former. Temperatures ranging from 800 to 4,000 can be observed with this instrument.



FÉRY PYROMETRIC TELESCOPE.

ELECTRO-PHYSICAL NOTES.

A New Fluxmeter.

AN instrument for directly measuring magnetic fields has lately been presented to the French Physical Society by M. E. Grassot. The principal is the same as that of a galvanometric method recently indicated by M. Féry. The instrument comprises a galvanometer of the d'Arsonval type, with very small torque and large damping coefficient. If an electromotive force be applied to the galvanometer coil, the latter not producing work will be deflected with a velocity such that an almost equal and contrary force is generated. Thus if α be the deflection and E the terminal P.D.:

$$\frac{d\alpha}{d} = KE, \quad \alpha = \int E\,dt$$

A flux Φ is also produced proportional to the deflection $\alpha = K\phi$, which is equal and contrary to $\int Edt$. Instead of applying an electromotive force, the terminals may be connected to a bobbin of known number of turns, and placed in a uniform field, when any variation of this field will generate a proportional E.M.F. E, and an observed deflection α correspond, measuring the variation of flux. The instrument is constructed by the "Compagnie pour la fabrication des compteurs," and is very simple and robust. It may be used wherever a ballistic galvanometer would be required, and has the advantage of being uninfluenced by neighbouring fields.

Further it cannot be put out of order, is direct reading, can measure slow variations of flux, which would be impossible by other methods, and its sensibility is independent of the circuit resistance.

Influence of Radium on Residual Electric Luminescence.

VACUUM tubes with platinum wires stretched out alongside their axes show certain phenomena of residual luminescence, the intensity of which is increased if during the action of the Rhumkorff coil the outer surface of the tube be grounded for some moments. If the positive pole be connected to the wire of the tube, flashes of light will be obtained throughout the tube on passing the hand along its surface. A similar luminescence is observed in the case of 25 mm. of radium bromide being present even at the distance of 1 m. The presence of radium during the working of the coil will noticeably augment the duration and intensity of the residual luminescence, as well as the duration and intensity of the phosphorescence in the case of the tube being charged from the negative pole. Analogous phenomena will take place at the temperature of liquid air. The phosphorescence of the tube-glass after the charge would cease completely on the tube being left for some time in liquid air, appearing again after its being reheated. According to the author, the hypothesis is suggested that the platinum wire will under these conditions give off emanations susceptible of condensation like those of thorium and radium.

On the Electronic Theory.

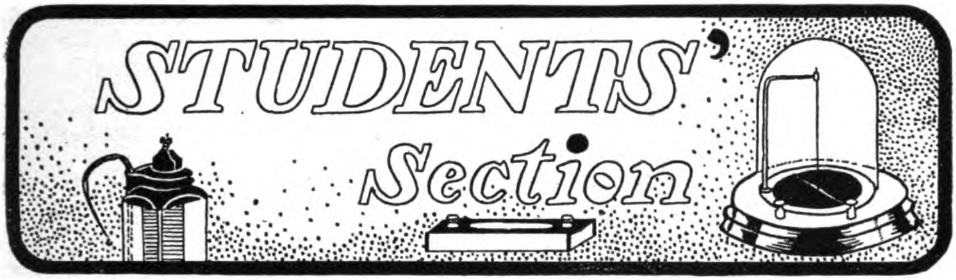
WHILE in most investigations on the theory of electrons an invariable spheric shape is assumed, for the latter it being understood that this is the most simple hypothesis, Mr. Searle as far back as in 1897 (*Phil. Mag.* 44, p. 340) pointed out that in the Heaviside field equation of a charge moving uniformly in the surface corresponding with the sphere in the state of rest is a flattened ellipsoid, the axes of which bear a ratio of $1 - \frac{v^2}{c^2} : 1 : 1$. It is then inferred that the simplest hypothesis is the one of a variable shape, the spheric form being present only in the state of rest, while an increasing flattening takes place in course of movement. This hypothesis is confirmed by the researches of H. A. Lorentz, having shown that most of the difficulties presented by the electronic theory, in view of the absence of an influence of the movement of earth on optical and electrical phenomena, will disappear when adopting these views. A further path in this direction is taken by Mr. W. Wien, who in a paper published in *Physikalische Zeitschrift* shows that the expressions known for the case of a single vibrating electron, on being applied according to Lorentz' scheme to the case of a movement, will give the formula established by the author for a moving source of radiation. According to the above views, the standpoint according to which any masses and any forces would have to be considered as being electronmagnetical is taking an ever-increasing importance, being the only means of accounting for the non-influence of the movement of the earth. The author, however, emphatically advises not to adopt these views too inconsiderately, but to leave open any other theoretical possibilities.

Ionisation in the Formation of Ozone.

THE electrical phenomena attending the oxidation of phosphorus in moist air induced Mr. S. Guggenheimer (*Physikalische Zeitschrift*) to make some experiments with a view to ascertaining whether similar oxidations are generally attended by ionisation phenomena. In the course of these investigations, he soon found ionisation to be always connected with a simultaneous formation of ozone, and in the present paper he records a series of experiments showing the oxidation of phosphorus to be attended by a strong ionisation only in the case of the formation of ozone by chemical means. In opposition to the views recently exposed by Richards and Schenck with respect to the analogy between the properties of ozone and those of radioactive bodies, the author thinks the two classes of phenomena to present some considerable departures from one another. In fact, whereas the influencing of photographic plates is generally taken as characteristic of radioactive bodies, a photographic effect is stated only to a certain extent in the case of ozone, while hydrogen peroxide is found to be electrically ineffective at atmospheric pressure, and according to the author at a series of pressures ranging from 675 and 24 mm. The oxygen separated catalytically from hydrogen peroxide by means of finely divided platinum is equally found to be perfectly inactive.

Aging Experiments on Dynamo Plates.

IN the *Elektrotechnische Zeitschrift* is a record of the aging experiments on dynamo plates carried out by the Hysteresis Committee, the results being as follows. New transformers will sometimes frequently, after some months in the laboratory at ordinary temperature, give higher losses than in the beginning, whereas the losses of the checking transformers used in connection with the experiments during an investigation of two and a half months did not show any further alteration, so that it would seem as if the loss co-efficients at ordinary temperatures will augment only for some time after completion, becoming constant afterwards. Excepting one of the sheets examined, all showed an aging tendency, the aging effect being, however, generally very small (3 per cent. to 8 per cent. of V). A strong aging effect, however, was stated in alloyed sheets being higher in the one holding 2 per cent. of Al (33 per cent.) than in the one holding 1 per cent. of Al (viz. 15 per cent.). The increase of the loss co-efficient was always due to an increase of the hysteresis loss, while the one produced by Foucault currents was generally found to remain constant. The figures found statically will generally agree with those found by a wattmetric method.



Students should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles of special interest to them.

Some Illustrations of Approximate Methods of Solving Problems.—III.

By ALFRED HAY, *D.Sc., M.I.E.E.*

AN examination of the curves of Fig. 9 shows that the current in the last section of our model of the cable rises extremely slowly at first; so slowly that a perceptible interval elapses from the instant of applying the battery before the current in CD (Fig. 8) becomes at all appreciable. The curve exhibits clearly all the features of the well-known "arrival curve" (or the curve connecting time with current at the receiving end) of an actual cable. In the case of an actual cable, however, the arrival curve will be somewhat different, owing to the fact that the capacity is not concentrated at two points as in Fig. 8, but is uniformly distributed. It is evident that by assuming the capacity to be concentrated at *three* points instead of *two*, a closer approximation to the actual cable problem may be obtained. It is instructive to study the changes in the "arrival curve" as the distribution of the capacity becomes more and more nearly uniform.

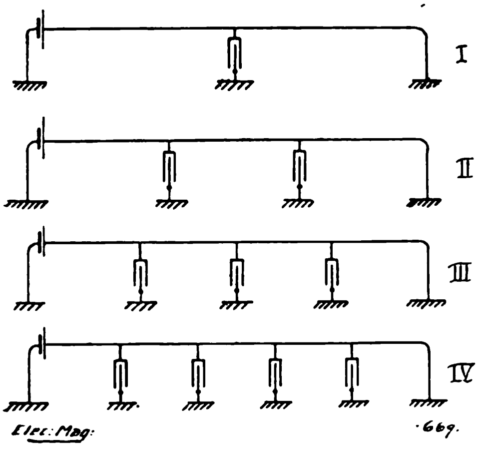


FIG. 10.

For this purpose, we shall work out the solutions for the four cases shown in Fig. 10, and marked I, II, III, and IV. In I the entire capacity of the cable—360 microfarads—is supposed to be concentrated at its middle point. In II—the case for which we have already obtained the solution—two capacities, each of $\frac{360}{2} = 180$ microfarads, are attached to points distant one-third and two-thirds respectively of the total length of the cable from the battery end. In III we have three capacities, each of $\frac{360}{3} = 120$ microfarads, concentrated at three equidistant points; and in IV four capacities, each of 90 microfarads, concentrated at four equidistant points. As we have already fully explained the method of calculation, it is unnecessary here to go into all the details, which the reader may work out for himself. The four arrival curves are shown in Fig. 11. In order, however, to enable the reader to plot these curves for himself, and to check the accuracy of his calculations, we give the table below (page 170).

These curves are plotted in Fig. 11, and a single glance at them immediately shows the effect of *distributing* the capacity. The more uniform the distribution, the slower is the *initial* rise of the current at the receiving end, and the more rapid is the *final*

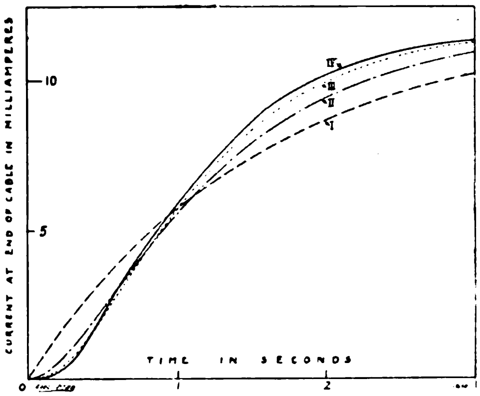


FIG. 11.

rise of the current to its steady value during the last stages of the current growth. Since any two curves cross each other, it is evident that there is, for each of the cases II, III, and IV, one particular value of the current at the receiving end which will be reached at the same time from the instant of closing the circuit, whether the capacity be distributed or entirely concentrated at the middle point. This value of the current is given by the point of intersection of the curve considered with the curve I.

Table of Arrival Curves.

Time in seconds.	0	.005	.010	.015	.020	.040
Current, arrival curve I	0	.0004	.0008	.0011	.0015	.0028
" " " II	0	—	.0002	.0003	.0005	.0017
" " " III	0	—	—	.0001	.0003	.0014
" " " IV	0	—	—	.0001	.0003	.0013

Time in seconds.	.080	.120	.160	.200	.250	.300
Current, arrival curve I	.0049	.0065	.0078	.0087	.0096	.0102
" " " II	.0044	.0067	.0083	.0095	.0104	.0110
" " " III	.0044	.0070	.0088	.0099	.0108	.0113
" " " IV	.0045	.0073	.0091	.0102	.0110	.0114

It will further be noticed that the difference between the curves I and II is very much greater than that between II and III, and the difference between II and III much greater than that between III and IV. That is to say, as the distribution becomes more nearly uniform, any further improvement in the uniformity of distribution produces a smaller effect than when the distribution is less uniform. From this we are justified in inferring that the difference between the curve IV and the actual arrival curve of the cable would not be very great, and we may regard curve IV as furnishing a sufficiently close approximation to the actual cable problem. If necessary, of course, still closer approximations may be obtained, but the reader who has taken the trouble to follow the details of the method explained, and who has worked out for himself the values for plotting one of the curves shown in Fig. 11, will readily understand that the solution of the problem becomes more and more laborious as the distribution is made more uniform.

THE PROBLEM OF THE OVERHEAD TRANSMISSION LINE.

One of the problems which have recently engaged the attention of many leading electrical engineers, and of which we now propose giving an elementary treatment, is that of a long-distance high-voltage overhead transmission line. An overhead line differs from an underground or submarine cable in possessing, in addition to capacity, another important property—inductance (or, to give it its old name, "self-induction"). A submarine telegraph cable, or a concentric electric light or power cable, does not give rise to any appreciable magnetic field. We may therefore assume that in the case of such cables the changes taking place in the current are conditioned solely by the resistance and capacity of the cable—as we did in dealing with the "cable problem." It is otherwise, however, when we come to consider an overhead line consisting of two conductors of given size and maintained a certain distance apart. When a current passes around the circuit formed by the two conductors, it gives rise to a considerable number of magnetic lines which become linked with the conductors. Any change in the current will involve a change in the magnetic flux linked with the circuit, and will hence give rise to an induced E.M.F. opposing the change (see *The Electrical Magazine*, vol. i. p. 520).

In investigating, therefore, the changes taking place in the current, we have to take into account not only the E.M.F. impressed on the circuit by some external source, but also the additional induced E.M.F. brought into play by the varying magnetic flux. If the inductance L of the line—*i.e.*, the magnetic flux linked with it when the current has a value of unity—is known, and if the value of the current is i, then the total flux is given by Li. Hence the induced E.M.F. is = rate of change of (Li) = L × rate of change of i. We may therefore look upon L as a coefficient which, when multiplied by the rate of change of the current, gives the induced E.M.F. If the rate of change of the current is given in amperes per sec., then the multiplier L which converts this into volts is expressed in terms of a unit known as a *henry*. The two conductors forming the line constitute a condenser, each conductor representing one "coating" of the condenser. In order to establish a definite

difference of potential between the conductors at any part of the line, electrostatic charges must be given to them corresponding to the given difference of potential. While these charges are being supplied, there is a *radial* flow of current in the conductors, and this radial conduction current is continued as a displacement current across the air-space separating the two conductors.* As a result of this, with a *varying* current (and therefore varying P.D.s), the current flowing through the cross-section of the conductors will, at any instant, vary from point to point of the line.

Let us suppose that we are dealing with a line 100 miles long, having a total resistance of 60 ohms, a total inductance of .3 henry, and a total capacity of 1 microfarad. Let the far-end of the line be insulated, and let a P.D. of 50,000 volts be suddenly applied to the line. The problem is to investigate the changes which take place before the steady state is reached, *i.e.*, before each wire reaches a perfectly uniform potential, the P.D. between the two wires being 50,000. As in the cable problem, so here we may substitute for the actual transmission line a model which is a rough representation of the line. We shall suppose that the capacity, instead of being uniformly distributed, is concentrated at the middle point and the end of the line. The arrangement is shown in Fig. 12.

In considering this model of our transmission line, we may regard it as consisting of two meshes or loops. In each of these loops the E.M.F., which is actually instrumental in maintaining the current through the resistance of the loop, and which is represented by the product ri (r being the resistance of the loop, and i the current), must be equal to the algebraical sum of all the E.M.F.s acting around the loop. Let us denote the differences of potential which exist at any instant across the middle and the end condensers shown in Fig. 12 by V and v respectively, and let I, i be the currents which exist at the same instant in the first and second sections of our model. Then, r standing for the resistance of either section and L for the inductance, we have, by what has been said above,

$rI = 50{,}000 - V - L \times$ rate of change of I . . (2)

and

$ri = V - v - L \times$ rate of change of i . . . (3)

In attacking our problem, we shall find it convenient to take a number of short inter-

* See *The Electrical Magazine*, vol. i. p. 295.

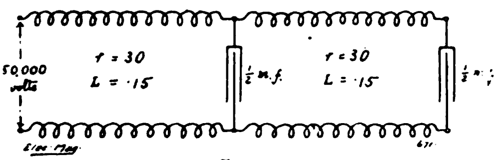


Fig. 12.

vals of time, and, assuming that during each of these intervals the rate of change of the current remains appreciably constant, trace the changes which take place in the other quantities. We may conveniently make all these time-intervals equal.

A very obvious difficulty at once presents itself. What value are we to assume for the duration of each short time-interval ? It is evident that this value cannot be assumed at random. If a random value were chosen which is too large, then the supposition that the rate of change of current remains constant during the time-interval would not hold even approximately, and our reasoning, based on this supposition, would lead to totally wrong results. From the point of view of accuracy, we may say that the time-interval cannot be chosen too small ; for the smaller it is, the more nearly constant will the rate of change of current remain during it. On the other hand, an excessively small value of the time-interval, though conducive to greater accuracy, necessitates a very large number of steps in our calculation, and so renders the solution extremely laborious. We have to try and strike a happy mean between these two extremes, and assume a value which, while yielding sufficient accuracy, does not entail excessive labour in our calculations.

We are led to a suitable choice by the following considerations. We know that the P.D. finally reached by both condensers is 50,000 volts. Let us take 5 per cent. of this, *i.e.*, 2,500 volts, and calculate approximately how long it will take the first condenser to reach this P.D. Let I be the value of I (the current in the first section) at the end of the interval. Since its initial value was zero, and since we assume that its rate of increase remains constant during the interval, it follows that the mean value of the current is ½-I . If x = duration of interval, then

$$\text{P.D.} = \frac{\text{quantity}}{\text{capacity}},$$

$$\text{or } 2500 = \frac{\frac{1}{2}\, I_1 x}{\frac{1}{2} \times 10^{-6}} = I_1 x \times 10^6,$$

whence $I_1 x = 2.5 \times 10^{-3}$ . . . (4)

Again, we have for the rate of change of current $\frac{I_1}{x}$. This we may assume to be equal to the initial rate of change, obtained by putting I = O and V = O in equation (2). This gives

$$0 = 50{,}000 - L\frac{I_1}{x} = 50{,}000 \times .15\frac{I_1}{x},$$

whence $\frac{I_1}{x} = \frac{50{,}000}{.15} = 3.3 \times 10^5$ . . . (5)

Dividing (4) by (5), we find $x^2 = \frac{2.5}{3.33} \times 10^{-8} = .75 \times 10^{-8}$, or $x = .87 \times 10^{-4}$ second.

Taking this as a rough guide, we shall adopt $.5 \times 10^{-4}$ second, for the duration of each of our intervals.

Let I_n, i_n, V_n, v_n denote the values of I, i, V and v respectively at the end of the nth interval, and I_{n+1}, i_{n+1}, V_{n+1}, i_{n+1} their values at the end of the $n+1$th interval. During this latter interval, the mean rate of change of I is obviously $\frac{I_{n+1} - I_n}{.5 \times 10^{-4}} = 20{,}000\ (I_{n+1} - I_n)$. Similarly, the mean rate of change of i is $20{,}000\ (i_{n+1} - i_n)$. Substituting these values in equations (3) and (4), and inserting also for I, i, V and v their mean values during the interval in question, we obtain

$$r.\ \tfrac{1}{2}(I_n + I_{n+1}) = 50{,}000 - \tfrac{1}{2}(V_n + V_{n+1}) - L \times 20{,}000\,(I_{n+1} - I_n),$$

and

$$r.\ \tfrac{1}{2}(i_n + i_{n+1}) = \tfrac{1}{2}(V_n + V_{n+1}) - \tfrac{1}{2}(v_n + v_{n+1}) - L \times 20{,}000\,(i_{n+1} - i_n).$$

Putting $r = 30$, $L = .15$, and re-arranging the terms, we find

$$3{,}015\ I_{n+1} = 50{,}000 + 2{,}985\ I_n - \tfrac{1}{2}(V_n + V_{n+1}) \ldots \quad (6)$$

$$3{,}015\ i_{n+1} = 2{,}985\ i_n + \tfrac{1}{2}(V_n + V_{n+1}) - \tfrac{1}{2}(v_n + v_{n+1}) \ldots \quad (7)$$

Again, the mean current charging the first condenser during the $(n+1)$th interval is $\frac{1}{2}(I_{n+1} + I_n) - \frac{1}{2}(i_{n+1} + i_n)$, and the increase of P.D. is $V_{n+1} - V_n$. Since the capacity is $\frac{1}{2} \times 10^{-6}$, the quantity entering the condenser during the $(n+1)$th interval is $\frac{1}{2} \times 10^{-6}(V_{n+1} - V_n)$. But this must equal the product of the mean value of the charging current into the duration of the time-interval. Hence

$$\tfrac{1}{2} \times 10^{-6}\,(V_{n+1} - V_n) = \left\{\tfrac{1}{2}(I_{n+1} + I_n) - \tfrac{1}{2}(i_{n+1} + i_n)\right\} \times \cdot 5 \times 10^{-4} \ldots \quad (8)$$

Similarly, considering the second or end condenser, for which the mean charging current is $\frac{1}{2}(i_{n+1} + i_n)$, we get,

$$\tfrac{1}{2} + 10^{-6}\,(v_{n+1} - v_n) = \tfrac{1}{2}(i_{n+1} + i_n) \times \cdot 5 \times 10^{-4} \ldots \quad (9)$$

Simplifying (6), (7), (8), and (9), we obtain the four equations:

$$I_{n+1} = 16.6 + .99\ I_n - .000166\ (V_n + V_{n+1}) \ldots \quad (10)$$

$$i_{n+1} = .99 i_n + .000166\,(V_n + V_{n+1} - v_n - v_{n+1}) \ldots \quad (12)$$

$$V_{n+1} = V_n + 50 \times \left\{(I_{n+1} + I_n) - (i_{n+1} + i_n)\right\} \ldots \quad (11)$$

$$v_{n+1} = v_n + 50\,(i_{n+1} + i_n) \ldots \quad (13)$$

which we shall use in our calculations.

The method of using these equations for calculating the values of I, i, V, and v at the ends of the consecutive time-intervals will be best understood by a study of the following detail-work connected with the first few steps.

First Interval.—In this case, n being zero, and I_n, V_n, i_n, and v_n being similarly all zero, equation (10) gives $I_1 = 16.6 - .000166\ V_1$. Now V_1 is not known, but as a first rough approximation we may assume it to be zero. We then get for I_1 the first rough value 16.6. Substituting this in equation (11), we find $V_1 = 50 \times 16.6 - 50 i_1$. Now i_1 is again unknown, and, as before, we provisionally assume it to be zero, thus obtaining $V_1 = 830$ volts. Inserting this into equation (12), and again as a first approximation putting $v_1 = O_1$ we find $i_1 = \cdot 000166 \times 830 = .138$. Lastly, using equation (13), we get $v_1 = 50 \times .138 = 6.9$.

We have thus obtained a first *rough* set of values for I_1, V_1, i_1, and v_1, and we proceed to make use of them for recalculating their values by means of equations (10) — (13), so obtaining a new set of *more accurate* values. Thus, putting $V_1 = 830$ in (10), we find $I_1 = 16.6 - .000166 \times 830 = 16.46$. Next, using (11), we find $V_1 = 50 \times (16.46 - .138) = .816$. Again, using (12), we get $i_1 = .000166\ (816 - 6.9) = .134$, and lastly, using (13), $v_1 = 50 \times .134 = 6.7$. We might, if necessary, proceed to a third approximation, again recalculating the values of I_1, V_1, i_1, and v_1. But, as will be seen presently, the new values so obtained do not differ appreciably from those of the second approximation. Thus, using (10), and putting $V_1 = 816$, we find $I_1 = 16.46$ practically, only the third decimal-place being effected. The same remark will be found to apply to the new values of i_1, V_1, and v_1. There is therefore no need to proceed further than the second step in this case.

(*To be continued.*)

ALTERNATING-CURRENT WORKING.

In continuing our abstract of the series of articles by Mr. W. B. Gump which have appeared in the *Western Electrician*, we may commence with that part which deals with the phase relation of the current and the impressed electromotive force. In Fig. 1 let the curve C denote an alternating current which varies from instant to instant according to the sine law, *i.e.*, varies harmonically; and since an E.M.F. is necessary to overcome the resistance and send the current through the circuit, an E.M.F. E_p may be drawn in phase with the curve C. The virtual value of the E.M.F., E_p is equal to the product C × R, —C being the virtual value of the current represented by the curve C—consequently the amplitude of the curve E_p will be greater or less than that of C according as R, the resistance of the circuit, is greater or less than 1 ohm. Then again, the magnetic field set up by the current will be alternating in character, exactly like the current, and will be in phase with it.

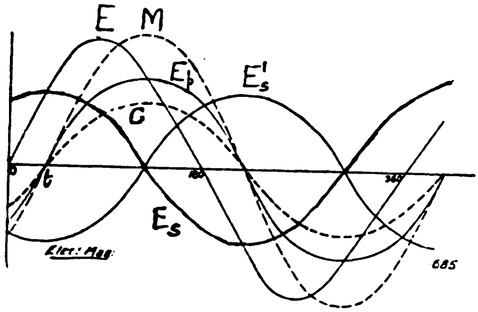


FIG. 1.

consequently the curve of M will represent the resulting magnetism.

Consideration of the laws of electro-magnetic induction and the variation of the magnetic field set up by the current makes it evident that an E.M.F. of self-induction will be set up in the circuit, so long as the current traverses the circuit. Now, at the instant that the current is a maximum, the time-rate of change in the intensity of the magnetic field is practically zero; consequently the value of the E.M.F. of self-induction at that instant will be zero. When, however, the current is passing through its zero value, the time-rate of change in the intensity of the magnetic field is a maximum, and at this instant the value of the E.M.F. of self-induction will be a maximum. Clearly, the time elapsing between maximum value of the current and the maximum value of the E.M.F. of self-induction is one-fourth of the periodic time, consequently the wave of the E.M.F. of self-induction will be displaced 90° relatively to that of the current, and in the figure is given by the curve E^1_s. According to Lenz's law, this E.M.F. tends to oppose the change in the instantaneous values of the current, and in fact neutralises a portion of the impressed E.M.F. which is equal in magnitude and opposite in phase to the E.M.F. of self-induction. This component of the impressed E.M.F. is given by the curve E_s (Fig. 1); another component of the impressed E.M.F. is that represented by the curve E_p, which may be called the *power E.M.F.*, since it overcomes the resistance of the circuit and thus does work. The other component, represented by the curve E_s, may be termed the *reactive E.M.F.*, since it neutralises the E.M.F. of self-induction due to the reactance of the circuit, and reacts upon the current in such a way as to give a phase-relationship between the current and the impressed E.M.F. This fact is shown very clearly in the wave diagram (Fig. 1), for inasmuch as the impressed E.M.F. must be the resultant of the two component E.M.F.s, *i.e.*, the power E.M.F. and reactive E.M.F. represented by the curves E_p and E_s respectively, the curve representing the impressed E.M.F. in magnitude and phase is obtained by adding together the ordinates of the instantaneous values of the two curves E_p and E_s. By plotting the sums of these ordinates, the curve, marked E in the figure, is obtained. The interval of time, *Ot*, which elapses between the instants when the impressed E.M.F. and current are respectively zero is a measure of the phase displacement, or angle of lag, which exists between the current and impressed E.M.F. in consequence of the action of the E.M.F. of self-induction which is set up.

The phase relations of the E.M.F. and current in an alternating-current circuit are more readily represented by a vector diagram as shown in Fig. 2, although wave diagrams are useful for exhibiting wave form. In Fig. 2, let the length of the horizontal line OB represent the power E.M.F. which overcomes the resistance of a certain circuit and is in phase with the current, and let OY denote the E.M.F. of self-induction which is set up by the reactance of the circuit and is 90° behind the power E.M.F. as regards phase. The reactive E.M.F. which neutralises this E.M.F. (*i.e.*, OY) is OX, and the resultant of the two vectors OB and OX is obviously OX^1, which consequently represents the impressed E.M.F. both in magnitude (according to the scale adopted) and phase. The angle θ or $< BOX^1$ is the phase angle or angle of lag

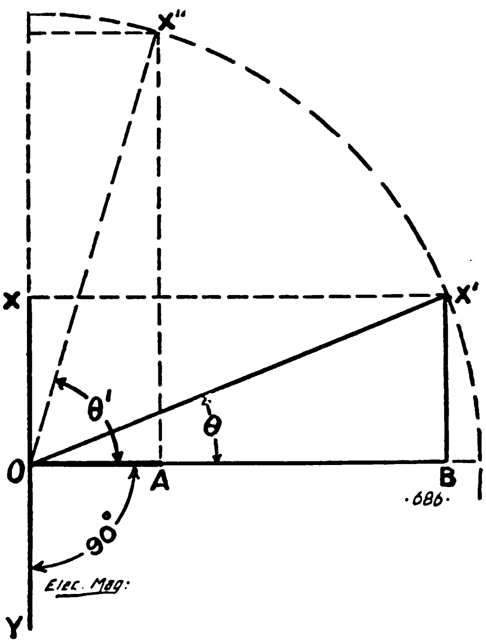


FIG. 2.

between the current and impressed E.M.F. From the geometry of the figure, we have

$$(OX^1)^2 = (OB)^2 + (BX^1)^2$$

$$E^2 = E_p^2 + E_s^2 \ . \ . \ . \qquad (1)$$

or (impressed E.M.F.)^2 = (power E.M.F.)^2 + (reactive E.M.F.)^2

$$\therefore \ E^2 = C^2R^2 + (2\pi f LC)^2$$

since $E_p = CR$ and $E_s = (2\pi f LC)^2$

$$\therefore \ E^2 = C^2 [R^2 + (2\pi f L)^2]$$

and $$C = \frac{E}{\sqrt{R^2 + (2\pi f L)^2}} \ . \ . \ . \ . \qquad (2)$$

This is the algebraical statement of Ohm's law for an alternating-current circuit containing resistance and reactance, and indicates the relationship which exists between the various numerical elements entering into the calculations of such circuits. The quantity $\sqrt{R^2 + (2\pi f L)^2}$ is the numerical value of the total obstruction presented to the current by an inductive circuit, and is known as *impedance.* Impedance is measured in ohms, and from equation (2) it is obvious that the magnitude of the impedance of a circuit is given by the ratio of the impressed E.M.F. to the current. As an example of the application of formulæ (1) and (2), a solution to the following problem is given.

Determine the current which traverses an inductive circuit of 32 ohms resistance and 0.03 henry inductance when an alternating E.M.F. of 1,000 volts and 70 periods per second is impressed on to the circuit. Also determine the angle of lag, the power E.M.F., and the reactive E.M.F.

The impedance $= \sqrt{R^2 + (2\pi f L)^2}$

$$= \sqrt{(32)^2 + (2 \times \frac{22}{7} \times 70 \times 0.03)^2}$$

$$= \sqrt{1024 + 174.24}$$

$$= \sqrt{1198.24} = 34.6 \text{ ohms.}$$

but $$C = \frac{\text{impressed E.M.F.}}{\text{impedance}}$$

$$= \frac{1000}{34.6} = 28.9 \text{ amperes}$$

The angle of lag, θ, is given by the angle BOX^1 (Fig. 2), and since BOX^1 is a right-angled triangle we have

$$\tan\theta = \frac{BX}{OB} = \frac{\text{reactive E.M.F.}}{\text{power E.M.F.}}$$

Now, the power E.M.F. is equal to C × R,

$$\therefore E_p = 28.9 \times 32$$

$$= 924.8 \text{ volts}$$

and the reactive E.M.F. is equal to $(2\pi f L) \times C$;

$$\therefore E_s = (2 \times \frac{22}{7} \times 70 \times 0.03) \times 28.9$$

$$= 13.2 \times 28.9 = 381.48 \text{ volts.}$$

$$\therefore \tan\theta = \frac{381.48}{924.8} = 0.413$$

from which θ is approximately 23°.

Fig. 2 also shows how the phase-relationship and the relative values ot the power E.M.F. and reactive E.M.F. change if the reactance be increased and the resistance be decreased.

Thus, if the resistance of the above circuit be decreased to 10 ohms and the inductance be increased to 0.075 henry,

the impedance

$$= \sqrt{10^2 + (2 \times \frac{22}{7} \times 70 \times 0.075)^2}$$

$$= \sqrt{1189} = 34.8 \text{ ohms.}$$

and $$C = \frac{1000}{34.8} = 28.7 \text{ amperes}$$

Also $$E_p = 28.7 \times 10$$

$$= 287 \text{ volts} = OA$$

and $$E_s = 28.7 \times (2 \times \frac{22}{7} \times 70 \times 0.075)$$

$$= 947.1 \text{ volts} = AX''$$

$$\therefore \tan\theta = \frac{947.1}{287} = 3.3$$

and $$\theta = 72^\circ \text{ (about)} = \text{angle } AOX''$$

Although the current is the same in both cases, it may be shown that the conditions of working are very different. This will be apparent when the terms "*true power*" and "*apparent power*" have been explained. Thus, in the first example the product of the voltameter and ammeter readings, *i.e.*, E × C, or 1,000 (volts) × 28.9 (amperes) = 28,900 watts indicates the power apparently supplied to the circuit; but, as already mentioned, the only work done in the circuit is the work done by the current in overcoming the resistance of the circuit, and this is given by C^2R or E_pC watts. This is termed the *true power*, and is equal to 924.8 (volts) × 28.9 (amperes) or 26726.7 watts. The former product EC is known as the *apparent power*, whilst the ratio between the true power and the apparent power is known as the power-factor of the circuit. Thus

$$\text{power factor} = \frac{E_pC}{EC} = \frac{E_p}{E}$$

but from Fig. 2

$$\frac{E_p}{E} = \frac{OX^1}{OB}$$

$$= \text{Cos}\,\theta$$

consequently the power-factor of the current is measured by the cosine of the angle of lag. Perhaps the meaning of power-factor will be grasped by considering the expression,

$$\text{true power} = \text{apparent power} \times \text{Cos}\,\theta.$$

Cos θ obviously gives the proportion of the power supplied which is spent in doing useful work, and this becomes the greater as the reactance is diminished. Thus, for the two cases considered the amounts of energy spent usefully are

$$924.8 : 287 = 3.2 : 1$$

although the same amount of power is supplied to the circuit in each case. The power factors are

$$\text{Cos } 23^\circ : \text{Cos } 72^\circ = 3.2 : 1$$

The actual power spent in a circuit at any instant is the product of the instantaneous E.M.F. by the instantaneous value of the current. The series of these products for a period is given by the curve P in Fig. 3, which shows that power is both given to and received from the line periodically, and it should be noted that the area of the negative lobe decreases as the angle of lag decreases, and *vice versâ*.

Another important element in alternating-current working is *capacity*, which expresses the ratio of the quantity of electricity charged upon a dielectric to the difference of potential caused by the charge. Algebraically

$$K = \frac{Q}{V} \quad . \; . \; . \; (3)$$

where K is the capacity of the conductor, Q the quantity of electricity, and V is the difference of potential to which the conductor is charged, and it is obvious that in

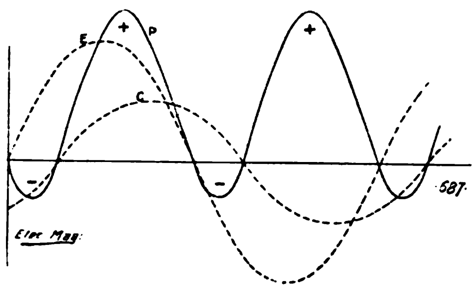


FIG. 3.

practical units the capacity of a condenser is measured by the quantity of electricity in coulombs which will produce a difference of potential between its terminals of one volt. The practical unity of capacity is the *farad*, so that a condenser which is charged to a difference of potential of one volt when charged with one coulomb of electricity has a capacity of one farad. The farad, however, is too large a unit for practical purposes, and a derived unit equal to the one-millionth part of the farad, and termed the *micro-farad*, is the recognised unit of capacity. Concentric cables in particular and ordinary cables used in everyday work possess capacity, and as the effect of capacity in a circuit traversed by an alternating current is opposite to the effect of inductance, and is the cause of a phase displacement between the current and the impressed pressure, the converse of that due to inductance, it follows that capacity effects play an important part in alternating-current working.

The following mechanical analogy is applied by Mr. Gump to explain the phase-relationship due to capacity: let S (Fig. 4) be a sphere (metallic or otherwise) attached at the middle of a rubber cord fastened at the two ends T and T[1] so as to hold the cord taut in a vertical position. Assume the portion above the X-axis to be positive, and that below to be negative, as indicated. Now let a stress be applied to the sphere in the direction indicated by the arrow, moving the sphere upward from its zero position. This force will correspond to a complete charge, and at this point the energy stored up is ready to be expended. In the figure, curve C corresponds to the charging current, and P is the curve corresponding to the condenser discharge pressure. When the current is a maximum, the condenser pressure is zero, and when the current is zero the condenser is charged to its maximum. There is thus a phase-relationship of 90° between the current and the condenser E.M.F., and in consequence of condenser reaction the current is displaced more than 270° relatively to the impressed pressure. It is for this reason that the current is said to *lead* upon the next wave of the impressed pressure by so many degrees. The measure of the *capacity-reactance* is given by $\frac{1}{2\pi f K}$ if K be the capacity in farads. If a circuit contains resistance and capacity-reactance the impedance of the circuit is given by the expression

$$J = \sqrt{R^2 + \frac{1}{(2\pi f K)^2}} \quad . \; . \; . \qquad (4)$$

and the algebraical expression of Ohm's law for such a circuit is

$$C = \frac{E}{\sqrt{R^2 + \frac{1}{(2\pi f K)^2}}} \quad . \; . \; . \qquad (5)$$

When the circuit contains resistance, inductance-reactance, and capacity-reactance, the impedance of the circuit is

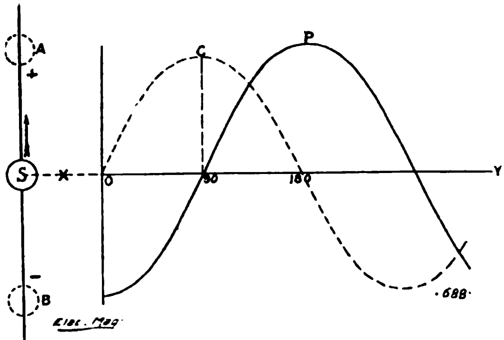


FIG. 4.

$$J = \sqrt{R^2 + \left(2\pi f L - \frac{1}{2\pi f K}\right)^2} \quad . \; . \; . \quad (6)$$

and the current is given by

$$C = \frac{E}{\sqrt{R^2 + \left(2\pi f L - \frac{1}{2\pi f K}\right)^2}} \quad . \; . \; . \quad (7)$$

It is evident from this equation that the impressed E.M.F. will be split up into three components, E_p, E_s, and E_k, which respectively overcome the resistance, neutralise the E.M.F.s of self-induction and capacity. The phase-relationship of E_p is 90° with respect to both E and E_k, whilst that between E_s and E_k is 180°, or in other words, they are directly in opposite. The magnitudes of these components are as follows :

$$\left.\begin{aligned} E_p &= CR \\ E_s &= 2\pi f LC \\ E_k &= \frac{C}{2\pi f K} \end{aligned}\right\} \quad . \; . \; . \quad (8)$$

The effect of capacity in series with resistance and inductance is shown very clearly by the solution to the following problem.

Determine the current which traverses a circuit consisting of a resistance of 32 *ohms, inductance* 0.03 *henry, and capacity of* 172.176 *micro-farads when the impressed E.M.F. is* 1,000 *volts at a frequency of* 70 *periods per second. Also determine the values of the components* E_s *and* E_k.

The reactance due to inductance

$$= 2 \times \frac{22}{7} \times 70 \times 0.03$$
$$= 13.2 \text{ ohms}$$

Reactance capacity
$$= \frac{1}{2 \times \frac{22}{7} \times 70 \times \frac{172.176}{10^6}}$$
$$= 13.2 \text{ ohms}$$

Impedance of circuit
$$= \sqrt{32^2 + (13.2 - 13.2)^2}$$
$$= 32 \text{ ohms}$$

$$\text{and } C = \frac{1000}{32} = 31.25 \text{ amperes}$$
$$\therefore E_s = (2\pi f L) C$$
$$= 13.2 \times 31.25$$
$$= 412.5 \text{ volts}$$
$$\text{and } E_k = \frac{C}{2\pi f K}$$
$$= 31.25 \times 13.2$$
$$= 412.5 \text{ volts}$$

E_s and E_k, being in opposition, neutralise one another, and the current is a maximum for the existing conditions ; but an important effect of capacity-reactance is still set up ; the capacity E.M.F. of 412.5 volts gives rise to pulsating currents across the insulation of the conductors, and a little consideration shows that a serious strain may be put upon the insulation should the resistance of the circuit be suddenly reduced. Suppose the resistance be reduced to 4 ohms, the current will be

$$C_1 = \frac{1000}{4} = 250 \text{ amperes.}$$

since the inductance-reactance and capacity-reactance are still equal and opposite, consequently

$$E_k = \frac{C_1}{2\pi f K} = 250 \times 13.2$$
$$= 3300 \text{ volts,}$$

which indicates the dangerous condition which may exist when capacity is present. The possibility of resonance effects being produced when the inductance-reactance is equal to capacity-reactance makes this part of the subject a most important one.

In the section dealing with alternators it is pointed out that alternators are essentially multi-polar machines, since the peripheral speed has a limitation, and the frequencies range from 25 to 100 cycles per second. Also that the armature is the revolving element in machines up to 300 k.w. capacity, but that in larger machines it is advantageous to make the armature stationary and to revolve the field magnets. This is because of the difficulties that are met with in insulating a revolving armature of high-tension machines and the field magnets are excited by means of low-voltage currents. In most alternators of the revolving magnet type the armature is outside and the field revolves within. The machines in use at Niagara, however, are exceptions, and are notable for the fact that the field magnets revolve outside the armature. Such a machine is known as the "umbrella type," the shaft being vertical.

The E.M.F. of a single-phase alternator may be calculated from the formula :

$$E = \frac{2.22 f NCn}{10^8 \times 60}$$

in which f = frequency, N = flux per pole, C = number of the armature conductors connected in series, and n = revolutions per minute.

With respect to the field excitation, it is pointed out that it is necessary to maintain a constant terminal pressure, and that there are several methods of effecting this by modifying the strength of the field, the simplest of which is rheostatic regulation by hand. A method of automatic regulation is shown diagrammatically in Fig. 5, in which a b are the armature coils and C the field coils.

The main field, C, receives current from the exciter, E, in the usual way, and the field strength of the exciter is controlled by the rheostat r. The strength of the field C is furthermore regulated, according to requirements, by means of the rheostat

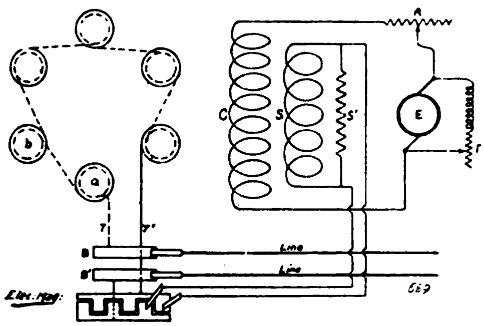


Fig. 5.

R. The terminals of the armature T and T^1 lead out to collector rings B and B^1, the terminal T^1 first conducting the current through the rectifier C^1 to the series coils S, whose strength is regulated by the shunt S . This arrangement corresponds to the continuous-current compound-wound machine, the series coil S strengthening the main field by virtue of the main current being conducted through it. Thus the voltage is controlled automatically.

From Fig. 6 it will be readily seen, as regards armature reaction, that as the armature moves in the direction of the arrow an E.M.F. will be set up in the conductors, the maximum value being reached when the opposite inductors of a coil are respectively under a N and S pole. The effect of the magnetism is to drag in the trailing-pole tips, and this is aided by the magnetism of the armature as well as that of the field. This increases the flux density in the pole-tips, which decreases the permeability. The length of the air-gap is also increased, hence the regulation of the machine is effected. If the current lags the armature will be in advance of the position shown in the figure. The effect will be to cause a distortion of the flux and a demagnetising action ensues. If the current is leading, then the opposite effect takes place, that is, the armature current is a maximum before the armature coil reaches the position shown ; hence the magnetism is cumulative. From these facts it is evident that an inductive load will affect the regulation, destroying the field, and decreasing the field strength. The regulation, therefore, is much better on a lighting load than

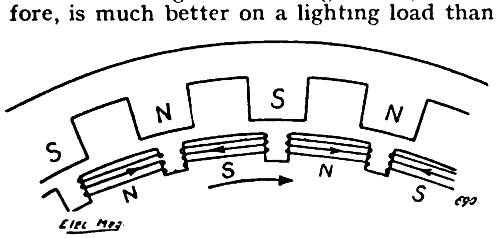


Fig. 6.

on a power load, especially on a line using induction motors. The latter tend to lower the power factor of the system, thus increasing the current output for a given power. Now all armatures are constructed with a comparatively low resistance, whilst the inductance L is generally so high that the reactance $2\pi f L$, in quadrature with the resistance, creates a high impedance. Most alternators, therefore, will stand a dead short circuit for a short time without injury. Alternators which are to run in parallel should have considerable armature inductance.

The terminal E.M.F. of an alternator under load is not the same as the E.M.F. on open circuit, the speed and excitation remaining constant. The E.M.F. of the machine on open circuit is made up of the following components, which can be added vectorially.

(1) Terminal voltage, E,
(2) Ohmic drop in the armature = CR = e_a,
(3) Armature induction drop, = e_s,
(4) Voltage loss due to reluctance by field distortion, = v_r,
(5) Voltage loss due to demagnetising action from a lagging current or magnetising action from a leading current = v_m.

The sum of the components ($e_a + l_s + v_r + v_m$) forms a mathematical quantity called the *synchronous impedance.* It is equal to the impedance which, if connected in series with the external circuit, having the same impressed voltage as that of open circuit, will cause the same current to pass as traverses the circuit under normal conditions. The synchronous impedance may be ascertained in the following simple way : Run the alternator at the proper speed, then short-circuit the armature through an ammeter. Now excite the field until the desired load is indicated ; whilst carefully observing the value of the current, break the load circuit and ascertain the open circuit E.M.F. This divided by the current will give the synchronous impedance. The component at right-angles to the armature resistance is termed the *synchronous reactance.* Combining it vectorially with the resistance, R, will give the synchronous impedance.

(*To be continued.*)

From Professor to Student.

Harry Church.—Your assumption that P will be zero in the case you mention is scarcely correct, since you have neglected to take into account the contact resistances. As you are probably aware, the difficulty experienced in the determination or comparison of very small resistances is due to the fact that the resistance at the contacts often exceeds the resistance of the conductor under test, especially in conductivity tests. For this reason the resistance P will not be zero, but 10,000 - S_a, when the galvanometer is connected to the terminal *a*, and the two extreme cases which you mention will not be realised in practice. The method, most probably, was devised to eliminate the effect of contact resistances, for which reason four readings have to be taken. As no change is made in the connections throughout the test it is obvious that no change will occur in the magnitude of the contact resistances to influence the results.

To prove the formula given, let the contact resistance at *a* be r, that between contacts *b* and *c* be r_2 and that at *d* be r_3; then by applying the principle of the Wheatstone's Bridge, we have

$$\left.\begin{aligned}\frac{10000 - S_a}{S_a} &= \frac{r_1}{X + R + r_2 + r_3}\\ \frac{10000 - S_b}{S_b} &= \frac{X + r_1}{R + r_2 + r_3}\\ \frac{10000 - S_c}{S_c} &= \frac{X + r_1 + r_2}{R + r_3}\\ \frac{10000 - S_d}{S_d} &= \frac{X + R + r_1 + r_2}{r_3}\end{aligned}\right\} \quad . \quad . \quad (I)$$

By adding one to each side of each equation we have

$$\left.\begin{aligned}\frac{10000}{S_a} &= \frac{X + R + r_1 + r_2 + r_3}{X + R + r_2 + r_3}\\ \frac{10000}{S_b} &= \frac{X + R + r_1 + r_2 + r_3}{R + r_2 + r_3}\\ \frac{10000}{S_c} &= \frac{X + R + r_1 + r_2 + r_3}{R + r_3}\\ \frac{10000}{S_d} &= \frac{X + R + r_1 + r_2 + r_3}{r_3}\end{aligned}\right\} \quad . \quad . \quad (II)$$

By division $\dfrac{S_a}{S_b} = \dfrac{X + R + r_2 + r_3}{R + r_2 + r_3}$

and $\dfrac{S_a - S_b}{S_b} = \dfrac{X}{R + r_2 + r_3}$ . . (III)

also $\dfrac{S_c}{S_d} = \dfrac{R + r_3}{r_3}$

and $\dfrac{S_c - S_d}{S_d} = \dfrac{R}{r_3}$ . . . (IV)

$$\therefore \quad \frac{S_a - S_b}{S_c - S_d} = \frac{S_b}{S_d} \times \frac{X}{R} \times \frac{r_3}{R + r_2 + r_3}$$

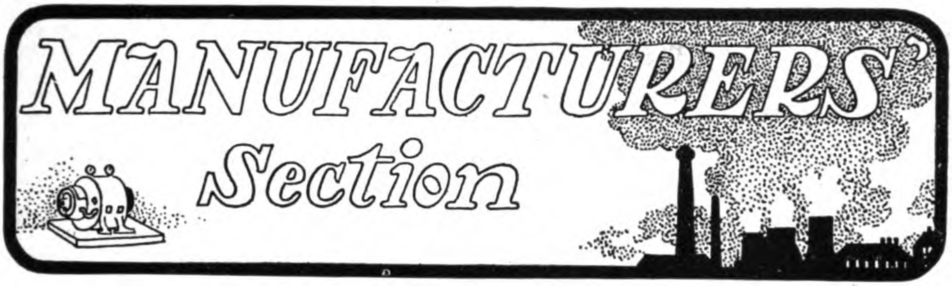
$$= \frac{R + r_2 + r_3}{r_3} \times \frac{X}{R} \times \frac{r_3}{R + r_2 + r_3}$$

$$= \frac{X}{R}$$

and $X = \dfrac{S_a - S_b}{S_c - S_d} \times R$

I WRITE to ask if you could, through the medium of your students' column, give me a brief idea of the nature and composition of various insulators, such as those used in armatures, transformers, &c.

The prime requisites in an insulator intended for generator, motor, or transformer insulation are (1) dielectric strength, (2) mechanical strength, (3) ability to withstand a high temperature. In addition to these, there is an important further requisite in the case of an insulator intended for oil-cooled transformers—ability to withstand the chemical action of the oil. A satisfactory insulator must, it will need hardly be added, be non-hygroscopic. When the conductors consist of thin copper wires, the usual double cotton covering is employed, and the coil on having been wound is heated *in vacuo*, all traces of moisture being thereby expelled; the coil is next thoroughly impregnated with a suitable insulating varnish, the varnish being sometimes forced into the cotton covering under considerable pressure. Various varnishes are employed, such as shellac varnish, P and B paint, Berrite, and sterling varnish. Shellac varnish is brittle when dry, and is attacked by oil. Sterling varnish is more flexible when dry and is capable of withstanding the action of oil. Shellac, which is the purified form of "stick-lac," is the product of an insect which deposits its eggs on the branches of certain trees in India; these masses of eggs are collected, enclosed in canvas bags and heated; the liquid which may then be squeezed out of them forms crude shellac. Shellac varnish is prepared by dissolving shellac in methylated spirit. The main ingredient of other varnishes consists of oil (linseed), which has become modified by the absorption of oxygen; the exact mode of preparation is, however, in most cases a manufacturer's secret. For insulating conductors of large cross-section, as well as for insulating former-wound coils from the armature core, mica, and the various insulators which consist chiefly of mica are most generally used. Mica is a mineral consisting mostly of a double silicate of aluminium and potassium (the aluminium may be replaced by iron, and the potassium by iron or magnesium); it is mined in New Zealand, Australia, Canada, Bengal, Madras, and Ceylon. It is characterised by the ease with which it may be split into extremely thin plates. As an insulator, mica possesses many valuable properties: it is non-hygroscopic, has a considerable dielectric strength, and is capable of withstanding a very high temperature. Indeed, there is only one weak point which renders its use, as such, undesirable in certain cases: this is its mechanical weakness. It is for this reason that various modifications of it are largely used, such as micanite and megomit. These insulators consist of thin sheets of mica which are cemented together by means of shellac or other insulating cement and which, when raised to a high temperature, may be moulded into any required shape, such as rings, tubes, &c. Mica is the only satisfacory insulator for use between the segments of a commutator. Micanite cloth and micanite paper, consisting of a backing of cloth or paper to which sheets of mica have been cemented, are also extensivsly used. For high-voltage work, mica is undoubtedly the best insulator, and it would probably also be more largely used in low-voltage machines were it not so expensive. Cheaper and more flexible insulators consist of specially prepared vegetable-fibre (cellulose), such as press-spahn (made of pure wood-fibre and finished with an oily glaze), vulcanised fibre and bond-paper treated with linseed oil.



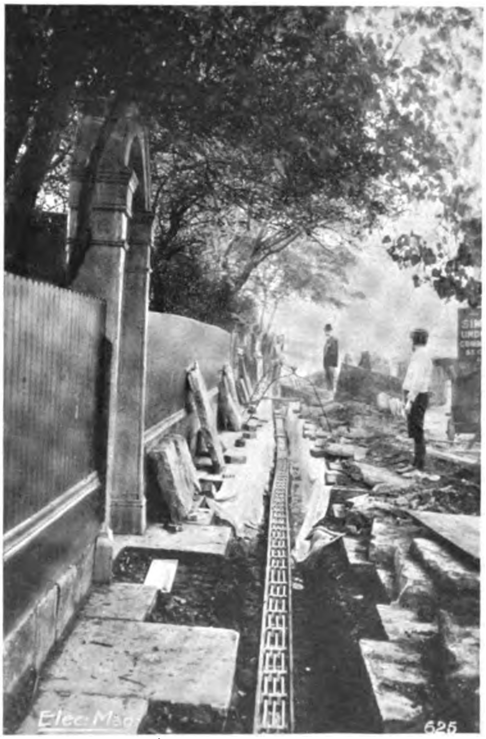
A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section at end of Magazine.

A Departure from Current Practice in Cable Laying

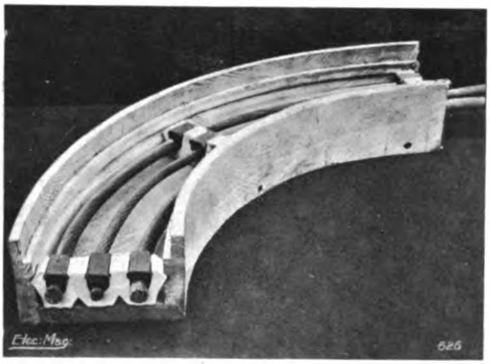
FOR some years past there has been a growing feeling among central station engineers and others responsible for extensive systems of underground electric mains that the existing methods of dealing with the distribution of electrical energy leave much to be desired both in the matter of simplicity and of immunity from subsequent troubles after laying. The idea has also become prevalent that some system by means of which the conductor could be laid in a trough and insulated *in situ* by surrounding it completely with some insulating compound poured into the trough in a molten state, after the manner of insulating bare connections in an underground joint-box, was the proper method of dealing with the problem. There was no doubt that several of the insulating compounds in common use for filling these joint-boxes, and known as box compounds, would be quite suitable for the purpose. Unfortunately, the high cost of manufacture of these made their adoption impossible for filling the troughs in which the conductors lay, and it was only by the discovery of a remarkable substance called "carbolite," having very extraordinary insulating properties, that the idea has been converted into a practical commercial success.

The advantages of such a system must be obvious to those dealing with existing systems of underground mains, eliminating, as it does, first, the lead-sheath, so often a source of trouble from chemical action due to surrounding impurities or to local electro-chemical action through stray leakage-currents; secondly, a hygroscopic form of di-electric, such as paper or fibrous material, with which great care is needed to prevent the entrance of the slightest moisture, a small amount of water getting into the cable at an end or at a carelessly made joint often travelling along the di-electric for considerable distances and involving the re-laying of the faulty piece.

The system brought out about three years ago, and adopted by the Simplified Underground Conductor Company, Ltd., of



LAYING CABLES IN SIMPLIFIED CONDUIT.



SECTION SHOWING CABLES, BRIDGE, AND BEND IN TROUGHING.

Liverpool, entirely obviates both these very fruitful sources of breakdowns in underground cables. It has been designed on thoroughly practical lines by two electrical engineers, who have made the subject of electric supply mains their special study for a large number of years, and in the past carried out a protracted series of experiments on a practical scale with a view to perfecting a system of distribution of electrical energy on the above lines.

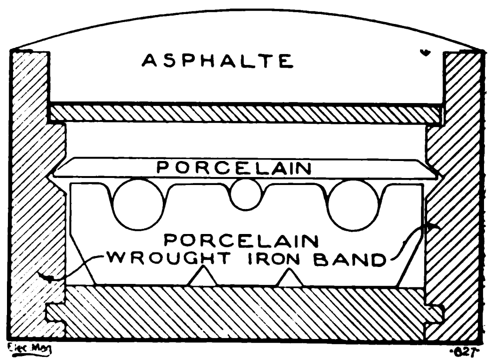
In this system, bare copper stranded conductors are laid on special porcelain bridges or bearers, placed at short intervals in a trough composed of iron, wood, or earthenware. After the conductors have been securely clamped down into position, so that they cannot move in any direction, the troughs are filled up by gradual degrees with molten carbolite insulating compound, which completely surrounds the conductors. The troughs are then finished off with a very tough asphalte cover, separated from the insulating compound by a thin inner lid of wood resting on a shoulder in the sides of the trough.

As a system of underground mains such as the " Simplified " Solid System is essentially one of great simplicity, and depending for its efficiency on only a few practical details, we think it will be of interest to our readers to describe rather more fully the various essential points of the system. After perusing these, we think it must be apparent that this is not simply a " paper scheme " but one which, as the inventors claim, " embodies the accumulated results of more than fourteen years' practical experience in handling and dealing with mains of all types on the older system."

Insulating Compound.—This is composed of refined carbolite, a material with high insulating properties, absolutely water-proof and non-hygroscopic, and which at the temperature of the surrounding soil sets to a very tough and slightly plastic consistency, capable of being bent to almost any extent without cracking. It has also an extraordinary power of resistance to break-down under high pressures, a length of *low-tension* main having recently been subjected under the auspices of the Liverpool University to an alternating difference of potential between conductors of 20,300 volts for ten minutes without showing any signs of breaking down. It contracts very slightly on cooling, but as an additional precaution against any possible trouble on this score the compound is usually poured into the troughs in gradual layers over a considerable length of main at a time, the final " topping-up " being done when the bulk of the filling has almost cooled.

Insulating Bridges.—Special attention has, we understand, been paid to the design and construction of these adjuncts of the Simplified Solid System, and a considerable amount of experimental work was necessary before exactly the right materials could be selected. The result has been the obtaining of a special mixture of Poole clays which, when burnt in the kiln, produces a porcelain body of high insulating properties, entirely non-hygroscopic and quite independent of any surface-glaze to resist the penetration of moisture.

In addition to its other advantages, a " Simplified " main can be overloaded to almost any extent, as, the conductors being clamped into a rigid material (porcelain), there is no question of that bugbear of overloading, viz., decentralisation of the conductor; and all that does happen is that the carbolite compound in the immediate vicinity of the conductor becomes temporarily slightly softened. This, however, has no injurious effect upon it, and on the removal of the excessive load the compound regains its usual solid consistency. This distinctive feature of the " Simplified " main is of especial value in connection with tramway-feeders; indeed, such a feeder laid on this system in the spring of 1903 has been working under an overload of nearly 20 per cent. without giving the smallest trouble since it was put down. The accompanying illustrations will serve to show



SECTION THROUGH CONDUIT.

SIMPLIFIED DISTRIBUTING PILLAR.

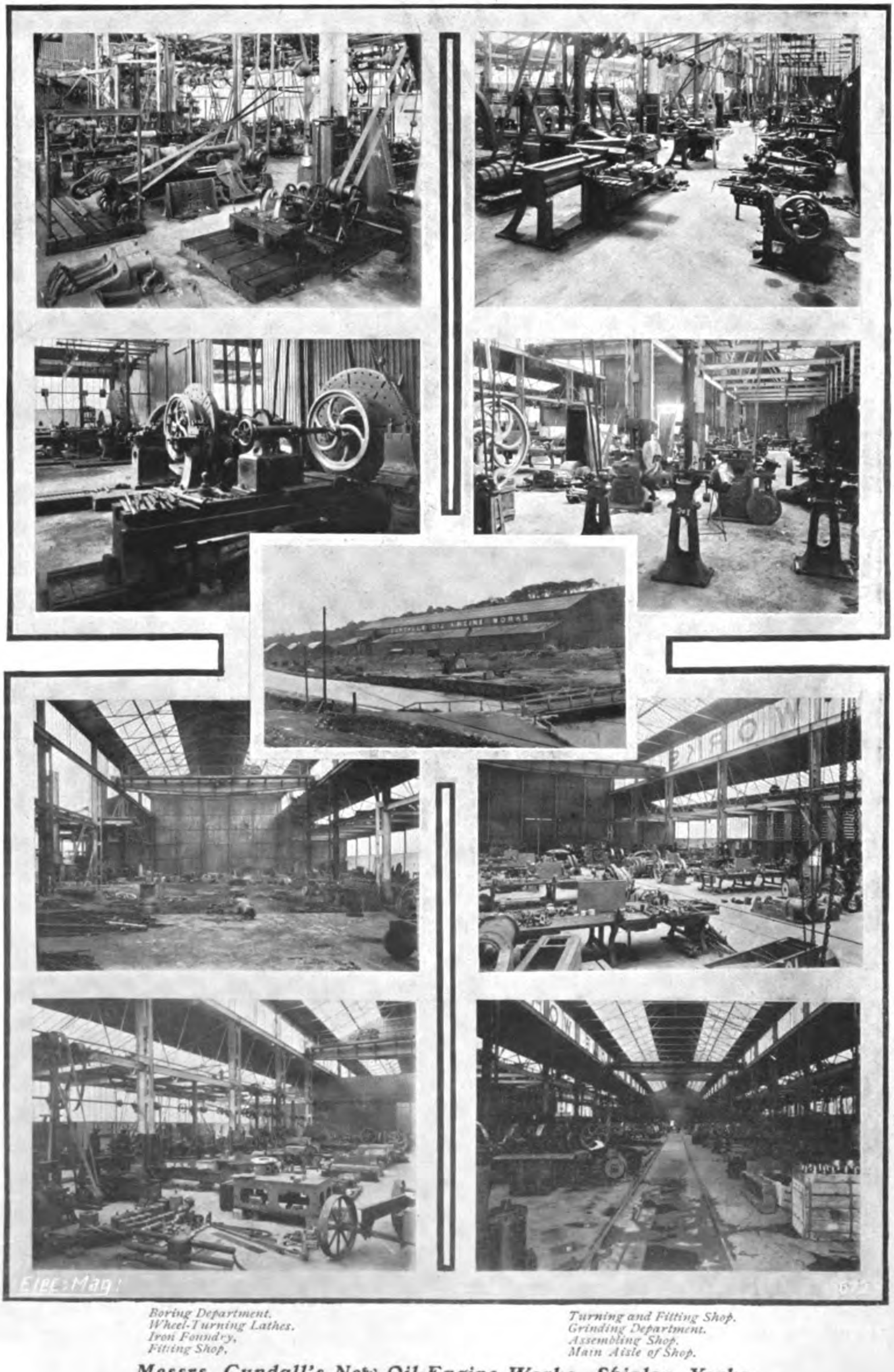
clearly the details of the system. Contracts for mains on this system have been carried out during the last three years for the Corporations of Blackpool, Salford, Bootle, &c., at Ledsham, Blundellsands, Witley, Eastham, and other places, the engineers in each case expressing their entire satisfaction with the working of the mains.

Carbolite Insulating Compound is being largely used in connection with lead-sheathed insulated cables laid on the older solid systems. By the use of this material in place of the usual bitumen as a trough-filling it is possible to obtain from end to end of the cable a very considerable insulation resistance between the lead-sheath and "earth," thus preventing any possibility of the lead-sheath being attacked electrolytically by any leakage-current in the ground. The complete insulation of the lead-sheath from the earth (where same can be effected at a reasonable cost) appears to be the proper solution of the trouble experienced in so many places with lead-sheathed cables, particularly in the neighbourhood of electric tramway systems, or where there is any considerable amount of leakage-current in the ground. It seems to have every advantage over the method sometimes adopted of earthing the lead-sheath at various points, as at some of these points there can be no reasonable doubt that the lead-sheath, being at places electro-negative to the earth, is actually *picking up current from the earth,* instead of getting rid of it, thus only aggravating the trouble at some other point. Carbolite has no action on the lead-sheath, and the price of this specially refined insulating compound suitable for use with lead-sheathed cables is on a par with that of the usual Trinidad bitumen. We understand carbolite has recently been exclusively specified by the Urban District Council of Brighouse in Yorkshire, as the trough-filling for use on the Council's electric lighting scheme; and large quantities are also being supplied for a similar purpose to the Corporation of Salford.

The Simplified Underground Conductor Company have also designed and brought out on a new principle a very neat and compact street-pillar, intended to take the place of the usual disconnecting net-work and feeder-boxes enclosed in brick pits built underground and roofed with a surface-frame and cover. A view of a 5-way pillar is shown herewith, and we are informed that the price compares very favourably with that of the underground boxes mentioned above. The wet weather of last year brought out very strongly the weak points connected with the system of placing disconnecting-boxes underground, but the many advantages of having all disconnecting arrangements above the level of the pavements and easily accessible in case of necessity are, we are sure, too well known to every station engineer to need reiteration here. The only consideration which has stood in the way of the universal adoption of above-ground pillars in place of underground boxes has been the hitherto high initial cost of the former.

Messrs. R. Cundall & Sons' New Oil-Engine Works.

CONSIDERABLE grit is needed to recover from the effects of two disastrous fires, and re-establish an engineering works on a sound footing. It has been the lot of Messrs. R. Cundall and Sons to meet with the above misfortune, while the manner of their recovery therefrom is typical of truly British doggedness. Inaugurated some twenty-five years ago as printers' engineers at Thornton, near Bradford, by Mr. Robert Cundall and his four sons, their earliest speciality was a book-folding machine, the immediate success of which necessitated the removal of the works to Shipley in 1884. The Cundall folder is now well known throughout the trade, and needs little mention here, seeing that we are chiefly concerned with the rise of this enterprising firm as gas- and oil-engine makers of repute. The first of the disastrous fires to which we referred above occurred in September 1899,



Boring Department.
Wheel-Turning Lathes.
Iron Foundry,
Fitting Shop.

Turning and Fitting Shop.
Grinding Department.
Assembling Shop.
Main Aisle of Shop.

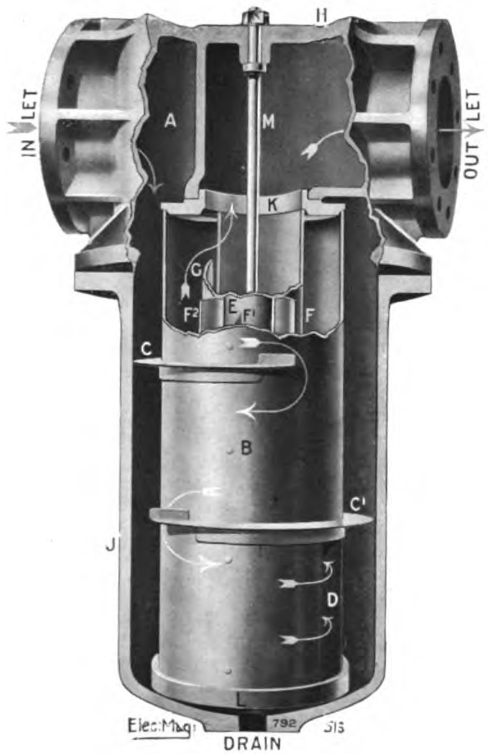
Messrs. Cundall's New Oil-Engine Works, Shipley, Yorks.

when the greater part of the Airedale works was destroyed, demolishing the whole of the gas-engine patterns, and doing incalculable damage to the oil-engine and folding-machine departments. The works were shortly rebuilt, and further additions made, in which modern labour-saving machinery of the best make was installed, and the new concern thus speedily raised on the ashes of its predecessor was soon got into working order. Early in July of last year the second fire occurred, and the whole of the buildings, with the exception of a portion of the foundry, was entirely demolished, all patterns and drawings being burnt. Nothing daunted, the four brothers who constitute the firm secured temporary premises, got extra draughtsmen and pattern-makers to work, and within a fortnight new machinery had been erected, and nearly one hundred workmen employed. During this time a site for suitable works was sought, and finally chosen in a very favourable position near the Midland and Great Northern Railways, and the Leeds, Liverpool, and Hull Canal. The best railway and water facilities were thus afforded the firm, who were not slow in placing themselves in connection with each one of them. The new works, of which we propose to give a short description, have been erected on this site, and the experience of the past has evidently prompted the management to erect an entirely fire-proof structure. Some five acres of land are covered by a main workshop, iron foundry, and pattern shop, as well as the usual drawing departments and offices. Brick, steel, and corrugated iron are chiefly used, and these materials should surely prevent any repetition of the previous disasters.

From a recent inspection which we were privileged to make, we can vouch for the up-to-date manner in which the works have been planned, and the modern appliances the firm have availed themselves of to expedite completion of orders. Electric driving has been adopted, and the motors arranged on the group system. Thus an element of economy is at once introduced, the advantages of which have been continually urged in these columns. The products of the firm in which we are chiefly interested are, as we mentioned before, gas- and oil-engines. These are constructed in sizes varying from 2 h.p. to 300 h.p., and embody the latest experience in their design and construction. We have already referred in our Power Section to the prospects of gas- and oil-engines for driving dynamos, and although Messrs. Cundall do not specially lay themselves out for work of this character, as makers of gas- and oil-engines they realise the potentialities of both machines, and as opportunity arises, they adjust their designs to existing requirements. This circumstance is noticeable in their present manufactures, consisting, as they chiefly do, of small gas- and oil-engines, for which at present there is an enormous demand. It is not difficult to realise, however, that should the electro-motor prove the active competitor to the small gas- and oil-engine which we anticipate it will be, the makers, seeing a market for such engines for driving dynamos and generating the power to operate these motors, will produce a suitable engine of either type for this purpose.

The main works building, constructed of brick, steel, and corrugated iron, as mentioned above, is 650 ft. long by 120 ft. wide. It is divided to form an iron foundry at one end of 250 ft. length, and a main workshop at the other end, 400 ft. in length. The latter contains the machine tools, specially divided into boring, shaping, turning, milling, and drilling departments, stores, testing department, and paint shop. The iron foundry is fitted with two large cupolas, which, however, have already proved too small to cope with the increasing demand. The 10-ton electric cranes span the centre bay, and serves both iron foundry and machine shop. There is a complete telephone system connecting each department, and everything is arranged to facilitate the passage of the work from one section to another with as little re-handling as possible. The pattern shop and drawing offices are contained in a separate building some 90 ft. square, in which wood-working machinery of the latest type is installed. A large stock of patterns is always kept on hand, and adjoining the shop is an extensive timber store. The isolation of these two important departments from the works should ensure against their destruction by fire. The works are lighted by British Thomson Houston arc lamps, the current for both lighting and power being supplied either from the Shipley Corporation or the firm's own private station. On the testing bed special provision is made for fixing and testing up to twelve engines at once, one pipe only carrying the exhaust from these to the atmosphere.

The gas- and oil-engines manufactured are of the horizontal type, and embody many interesting and novel features. The fuel consumption of these engines is also remarkably low. A special type is developed for electric lighting apparatus, and we understand that arrangements are being made to put on the market an engine suitable for direct connection to dynamos. As occasion arises we shall refer to these engines in this Section. Meanwhile we will conclude our description of these interesting works by a word of congratulation to the management on the spirited and workmanlike manner in which its exceptional difficulties have been overcome, and a successful business established and maintained.



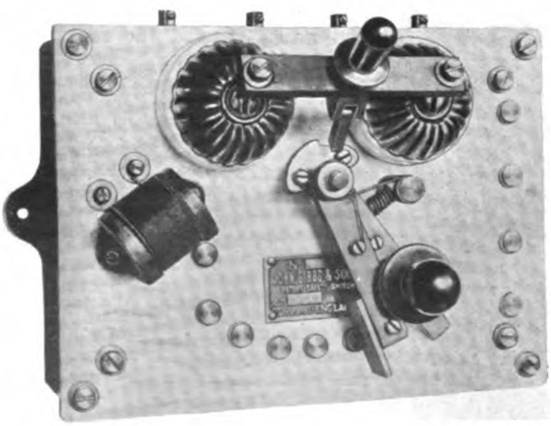
SECTIONAL ELEVATION OF STEAM DRYER.

A NEW STEAM DRYER.

We illustrate this month a new form of Steam Dryer, recently introduced by Messrs. Holden and Brooke, Ltd., West Gorton, Manchester. In this apparatus baffles and such devices are entirely superseded, the steam flowing in unbroken stream from inlet to outlet, while the water extraction is continuous, and operates on the whole of the steam passing through the separator Referring to the illustration, two separate cylinders, B and E, fit into circular grooves in the plates K and L, a common bolt M passing through the separator top to the plate L, and retaining the cylinders rigidly in position by a nut on the outside of the separator. At the same time this permits of easy dismantling when required. The steam enters a receiving chamber on the left, passing downwards into an annular space between the outer casing and the cylinder B, following the course indicated by the arrows to the opening D. Before reaching this point, however, the steam has been divided into two currents each of which must follow a circular course equivalent to one and a half times round B, this being effected by the galleries C and C¹, which also cause the steam to reverse its direction twice. This action is again repeated in a modified form during the passage of the steam between the cylinders B and E and the outlet. The water collected falls on galleries C and C¹, and flows down the sides of the casing or cylinders to the bottom of the separator. It is clear that even should a particle of water or grit which has entered the separator retain velocity enough to travel round the first curve it will be practically impossible for it to double on itself and get round the second. When once the water is extracted from the steam, it cannot be again taken up. A suitable drain is provided at the bottom of the separator, which can be connected to the steam trap, or the water by suitable means returned to the boiler itself. We understand that the separators are entirely free from wire drawing, and do not reduce the pressure of the steam in any way. The device is made in standard sizes, but other patterns are furnished to suit special requirements.

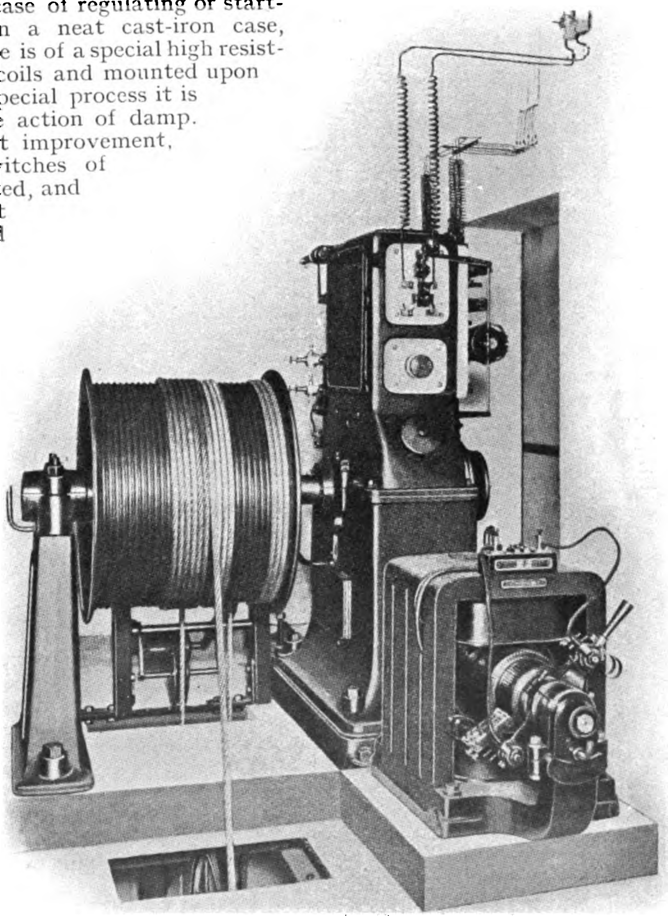
AN IMPROVED TYPE OF STARTING SWITCH.

The constantly increasing demand for a good substantial and inexpensive starting and regulating switch has induced Messrs. John Gibbs and Son to produce an improved form of their interlocking double pole quick-break starting switch, an illustration of which we give herewith. In this switch the regulating and connecting arms are so interlocked with the double pole switch that it is impossible to start the motor unless all the resistance is in circuit. In addition, the switch is fitted with a no-voltage release, which, on failure of supply, causes the regulating and connecting arms to fly back instantly to their "off" position, thus breaking the circuit and obviating any possibility of its again being connected to the motor.



MOTOR STARTING SWITCH, SHOWING INTERLOCKING DEVICE.

All current-carrying parts of the device are of ample section for the work required of them, and the resistance itself either in the case of regulating or starting switches is contained in a neat cast-iron case, suitably ventilated. The wire is of a special high resistance quality wound in spiral coils and mounted upon porcelain insulators. By a special process it is protected from the corrosive action of damp. This in itself is an important improvement, as many of the coils in switches of this nature are not so protected, and after being in use a short period the wire breaks and renders the switch useless. The double pole main and motor terminals are situated at the top of the resistance box, and are capable of being efficiently protected to prevent damage by contact with any foreign material. Our readers will be interested to know that Messrs. John Gibbs and Son had their patents on the older type of this switch recently opposed in the German law courts. This action was, however, defeated, and letters patent finally granted to them. The ultimate result of this action will, no doubt, greatly increase the value of the patent, both in this country and abroad. The makers especially recommend the switches for use with their dust-proof motors direct-coupled to air propelling and ventilating fans. With this controlling device the fans can be run absolutely silent (say, during a concert), while in the interval they can be switched on to full-speed to clear the assembly-hall of vitiated air. The range of speed obtainable with the switches is very large, and is capable of six variations between the slowest and full speed.



STIGLER'S ELECTRIC LIFT GEAR.

STIGLER'S DIRECT COUPLED ELECTRIC ELEVATORS.

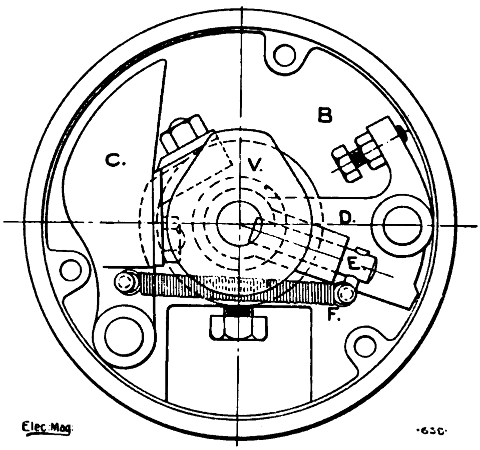
THERE are many types of electric lifts on the market, and a considerable preference has been given to that form in which the switch gear is entirely independent of the travelling cage, and is operated therefrom by a pull rope, similar to that used in hydraulic lifts. In the Stigler electric lifts, however, the controlling of the motors is effected electrically from the elevator itself, and moreover arrangements are made for automatically stopping the lift at any floor. This is possible with a patent push button arrangement, which is a speciality of the makers, Spagnoletti and Co., Goldhawk Road, Shepherd's Bush, W. The illustration reproduced herewith depicts the motor and controlling gears for the roof type of this lift. The motor is coupled to the lifting apparatus proper through a flexible insulating coupling, and drives a gun metal spur wheel through a steel worm, the gearing running in an oil bath. The worm teeth are cut in such a manner as to avoid running back should the brake fail to act or current be interrupted during the

travelling of the cage. The cast iron winding drum is operated from the spur wheel, and is turned and grooved to receive the lifting and counterbalance weight ropes. The motor and gearing are mounted on a substantial bed-plate, fixed in the basement or over the lift well, of the building employing the lift. The push button control provides for the stopping of the car at any floor, the pushes being numbered to correspond with the various landings. After closing the door, by pushing the button corresponding to the floor at which it is desired to alight, the car will at once start, and stop automatically at that floor. The push buttons operate a number of magnetic switches, which can be seen mounted above the motor on the complete apparatus over the well. Until the doors of the cage or those of the lift enclosures are first closed, the lift cannot be started, as a special electric brake comes into operation. Should the doors of either the cage or the enclosure be allowed to open whilst the car is in transit, its motion will be immediately arrested by the application of the brake. This safety apparatus can be fitted to lifts with rope-operated controllers, in which case solenoids are placed above the cage and connected to a series of wires running up and down the lift well to contacts on the enclosure and cage doors. An automatic locking arrangement is also fitted to the enclosure doors, preventing them being opened while the car is in motion. The design generally illustrates the extreme flexibility of an electric system, and the ease with which certain desirable precautions can be carried out.

A NEW GOVERNOR FOR OIL ENGINES.

THE governors commonly used on gas- and oil-engines leave much to be desired in their method of driving from the layshaft. The belt or gear flyball type moving a roller into or out of action with the admission-cam always seemed subject to improvement, and we are pleased to note that a neat governor has at last been produced devoid of these undesirable features, while embodying many of a novel character. This governor was awarded a silver medal at the recent Agricultural Show held at Park Royal, and is the product of Messrs. Blackstone and Co., Ltd., Stamford.

The construction of this governor is as follows: On the layshaft of the engine is keyed a drum or casing B, inside and near the periphery of which is pivoted a weighted lever C, carrying a ledger plate which bears against a ledger rigidly connected with the cam V. This cam is carried on a lever D, similarly pivoted inside the drum, and projects from one side of the casing. The lever D carries a rod, one extremity

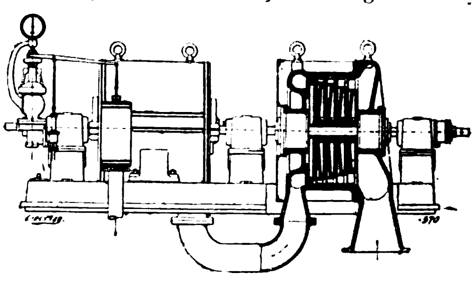


SIDE VIEW OF OIL ENGINE GOVERNOR.

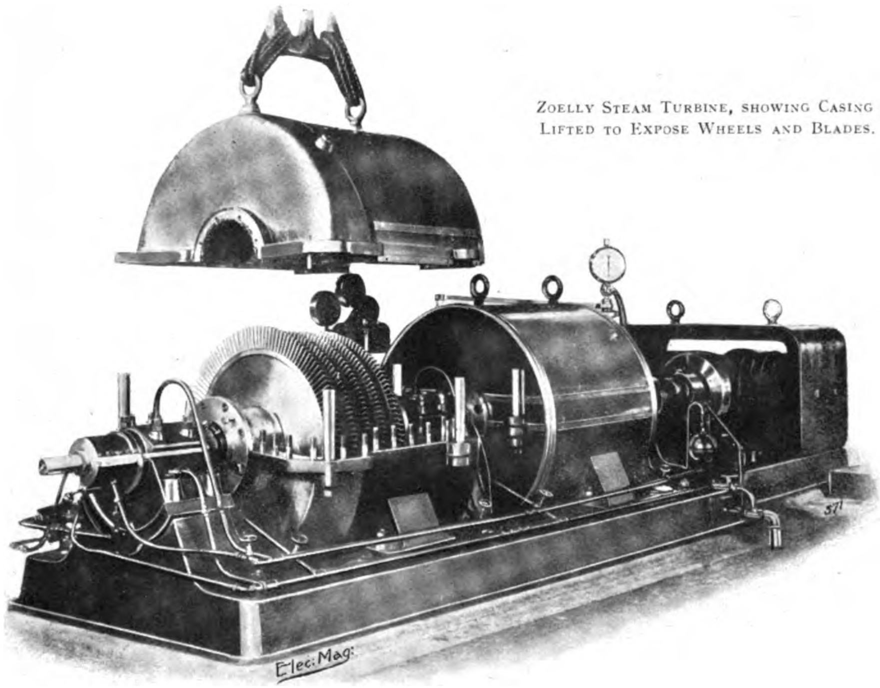
of which projects into a central hole formed in the cam, the other having attached to it one end of a spring F, this spring having its other end attached to the weighted lever C. When the engine is running at normal speed the spring F holds the weighted lever C, so that its ledger engages the cam-ledger, the cam V being thus held rigid and operating the vapour valve-lever on coming in contact with it. When this speed is exceeded the weighted lever C moves outwards under the influence of centrifugal force, the cam-lever D is thus deprived of its support, and is only held in position by the spring F, which yields when the cam strikes the vapour valve-lever, so the latter is not actuated. The speed of the engine is adjusted whilst running by a taper pin introduced into the central hole of the cam V, which moves the sliding rod E, thus regulating the tension of the spring F.

THE ZOELLY STEAM TURBINE.

A LARGE syndicate has been formed by some of the foremost German firms (among which there is Friedrich Krupp, Essen, the North German Lloyd and the Vereinigte Maschinenfabrik Augsburg u. Maschinenbau-gesellschaft Nürnberg) for the exploitation of an improved type of the Zoelly steam turbine just brought out by



SECTION THROUGH ZOELLY TURBINE.



Zoelly Steam Turbine, showing Casing Lifted to Expose Wheels and Blades.

the Swiss firm of Escher Wyss et Cie., Zürich.

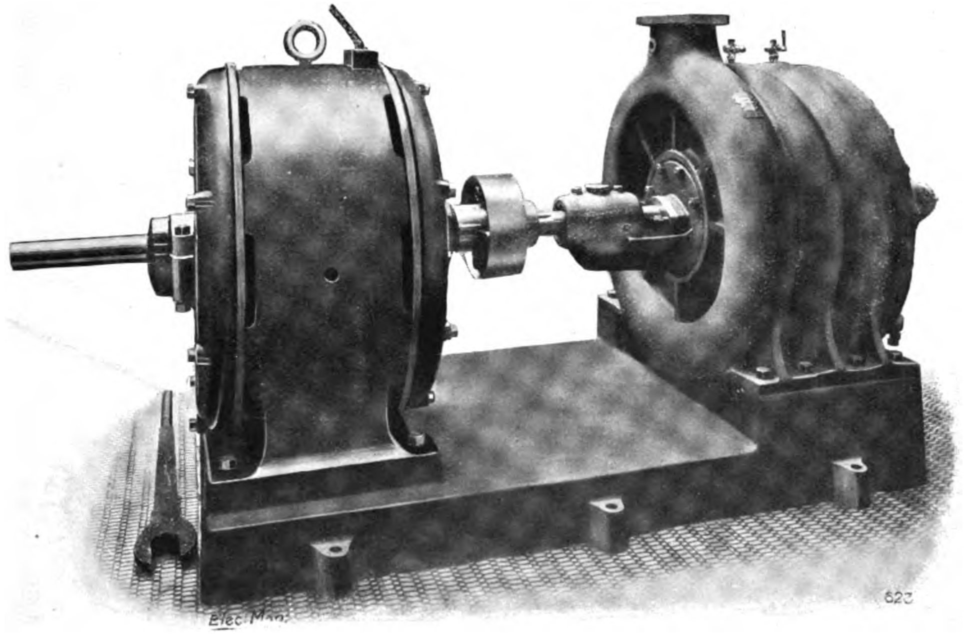
The turbine is a multiple step-axial action turbine, where the steam is conveyed to the running-wheels through guiding-wheels, so as to have in the high-pressure step a partial, and in the low-pressure step a total, charge. There is one running-wheel between each two guiding-wheels, the latter being fitted steam-tight into the turbine casing; the running-wheels are mounted on a common shaft, traversing the whole length of the turbine. On the rim of the discs are mounted the turbine-buckets, which have the form of relatively long rays, their cross-sections increasing at a regular ratio from outside inwards towards the axle of the wheels, so as to maintain constant the specific strain throughout the length of the bucket, and to secure a high resistance both with respect to the centrifugal force and steam pressure. Comparatively high wheel-diameters, and accordingly great peripheric speeds, may thus be adopted, allowing of a much smaller number of steps being used than with steam turbines of other systems. The regulation of the turbine is secured very efficiently by means of an extremely sensitive spring governor, which controls the admission valve, the steam pressure being altered according to the load. A further feature is that the turbine-shaft is located outside on a base-frame, quite independently of the turbine casings, so as to avoid any action of the steam-heat or of the thermic expansion of the turbine casings on the bearings; the latter, moreover, are so arranged as to be readily accessible. The safety of working is warranted largely by the absence of any compensating pistons, the great clearances between the moving and stationary parts of the turbine, the simplicity and solidity of the running-wheels, the small number of the latter, &c. A turbine direct coupled to a rotary current generator built by the Siemens Schuckert Werke is being operated in the workshops of the company, having an output of 600 h.p.

ELECTRICITY WORKS BUILDINGS.

Mr. C. H. Merz, in his recent paper on "Power Stations," read before the Institution of Electrical Engineers, recommended the use of a steel framework filled in with galvanised iron for housing the plant in large power houses. He has adopted this construction at the new Carville Power Station of the Newcastle-on-Tyne Electricity Supply Company, and although his suggestions did not meet with the approval of the majority of electrical men who listened to his paper, the marked saving to be effected by putting them into practice will probably be responsible for a large number of such stations in the future. The time taken to erect a power house is phenomenally long, and unless some lighter form of construction be employed, is unlikely

to be materially reduced. The steel framework with corrugated iron filling, however, if generally employed, would result in the station being practically complete some time before the plant was ready for installation. Manufacturers know to their cost what trouble arises on the delivery of plant at an incomplete power house. The argument raised by several electrical men criticising Mr. Merz's suggestion that machinery costing many thousands of pounds could not safely be housed in a "tin" building, is considerably discounted by the risk of damage due to exposure to which machinery is subjected when delivered to incomplete buildings. We have heard a good deal about record steel work recently, and in this particular referred to the building of Messrs. Graham Morton and Co.'s Works, Leeds. We are now favoured with details from the same Company of some smart roof-building work recently carried out by them. This comprises the roofing in of a number of platforms at the Great Northern Station, Leeds. The contract included 26 principals, 36 columns, 36 cantilevers, and 15 lattice girders, a total weight of 118 tons. This was filled in by 462 panes of glass, comprising 5800 square feet, while the total area of station and platform covered amounted to 28,700 feet. In addition 12,500 feet of Vielle Montagne Zinc were used, and 15,000 feet of tongued and grooved match-boarding. The order for this work was placed on Friday, May 20, just before Whitsuntide. Owing to the suspension of business for holidays, operations were not started until the 25th. The erection of the iron-work commenced at 10.30 on Saturday night, June 4, and by noon on Sunday, the 12th, the last piece of iron-work was fitted, the total working time put in being forty-two hours. By six of the morning of June 20, the whole of the work was completed, giving a total of sixteen days from the time that the erectors were first on the ground. The time limit for the completion of this contract did not expire until July 25, just five clear weeks later. A glance at the accompanying figure will give some idea of the roof construction and serve to bear out our remarks made above as to steel construction for electricity works, and the ease and speed with which such can be erected. Seeing that so much depends on the capital expenditure on electricity works, and that considerable economies can be effected in the building of the power house itself, there should be considerable prospect of such structures as were suggested by Mr. Merz becoming the rule rather than the exception in power house construction. Should this come to transpire, and we see no reason to the contrary, the records recently standing to the credit of Messrs. Graham Morton in erecting engineering works and structures similar to that described above can be extended to the building of large power

VIEW OF STATION SHOWING STEEL ROOF WORK.



WORTHINGTON THREE-STAGE TURBINE PUMP.

houses in one-tenth of the time absorbed in the costly structures now favoured by engineers.

A THREE-STAGE TURBINE PUMP.

IN our last issue under the notice of the Colliery Exhibition recently held at the Agricultural Hall we mentioned the exhibit of the Worthington Pump Co., Ltd. Our illustration depicts a large turbine pump which was on view at that time and which is representative of a type of pump now receiving much attention at the hands of engineers. Its capabilities have so far merited the confidence placed in it, and its employment in conjunction with the electric motor, which can be directly coupled to it, has been the means of bringing it prominently to the front. In previous articles we have referred to its advantages over ram pumps of even the most improved kind, and in this respect it is of particular value in colliery work. The pump illustrated has three impellers on the same shaft, as may be seen by the ribs in the pump casing. It is coupled direct to an induction motor (Westinghouse Type C) of 140 b.h.p., and when driving the pump at 1460 r.p.m. gives the latter a capacity of 800 gallons per minute against a head of 400 ft. A combination of motor and pump such as that described is exceptionally valuable for working in confined spots underground. Even in floods little damage can ensue to either motor or pump, and the former after drying out will generally be found fit for continued and reliable service. We understand that pumps of this type are being designed by the Worthington Pump Co. for pumping against a total head of 2000 ft.

The Potential Fall in Alternating Current Generators.

DR. H. BEHN-ESCHENBURG some years ago suggested a simple method for predetermining the tension-fall in alternating current-generators, the underlying principle being as follows :

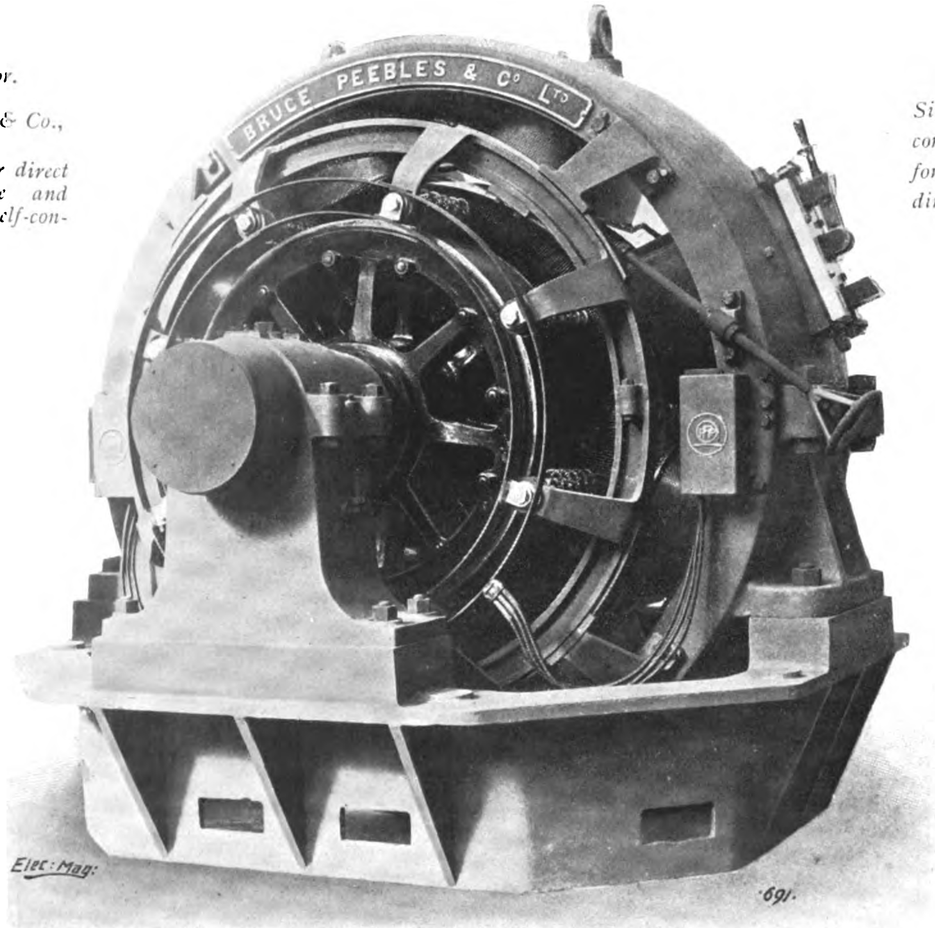
From the calculated or observed short-circuit characteristics of a generator for the various degrees of saturation of the magnetic system, there are calculated different values of the internal impedance, which, on being multiplied by the load-current intensity, represent the amount of back e.m.f. In another method, eventually suggested by Mr. Rothert, the short-circuit characteristic of the generator was used to calculate the equivalent of the magneto-motive force of the inducing magnet coils, corresponding to a given back e.m.f. of the loaded induced coil. In a paper recently published in the *Elektrotechnische Zeitschrift*, Dr. Eschenburg shows how both of these methods may be corrected so as to give better results.

Manufacturers should not lose sight of this section of the magazine. It enables them to give publicity to new apparatus in a manner well-nigh impossible with any other technical journal.

If you have any novel electrical device, be it light or heavy, send us a description of it. We do the rest.

Traction Generator.
Makers:
Messrs. Bruce Peebles & Co.,
Edinburgh.

Dynamo suitable for direct connection to engine and mounted on its own self-contained bed-plate.



Output 600 k.w. 240 r.p.m.
Six similar sets now being constructed for the Admiralty, for Chatham Dockyard, to be direct coupled to Belliss engines.

Standard Types of Electrical Apparatus. II.

The World's Electrical Literature Section at end of Magazine contains a classified list of all articles of interest to Central Station men. Consult it and save yourself much valuable time.

Faults on Underground Mains: A Remedy. II.

By JAMES CLEARY.

(*Continued from page 662.*)

AMONGST engineers generally much prejudice exists against triple-concentric cable, chiefly on account of the unreliable system of jointing usually employed, and many who condemn it on this score would gladly avail themselves of its undoubted advantages were they assured that these difficulties could be satisfactorily overcome. What was said by the writer against the iron-box, for jointing on single cables, may be repeated respecting triple-concentric cable, the risk from moisture in the case of the latter being greater, owing to the conductors of opposite polarity being so close.

The two principal types of iron-boxes generally used for concentric and triple-concentric house services have each their own objections. Taking first the box with open ends, pockets, and slides. This depends on the compound to keep out damp, and as the slides are incapable of retaining the compound without the usual packing of earth around the cable-holes it forms anything but a mechanical job. The least unevenness of the ground or strain on the cable upsets the level of the box, and the compound leaks out. Further, the shrinkage of the compound on cooling inside a box, the lid of which is *not* designed to keep out water, gives the reader some idea of the drawbacks of this system. All that can be said in its favour is that the joint can be made on "live" cables—a necessity at the present day on any supply undertaking of importance.

The other type of box is certainly more creditable to the designer. Instead of the end slides, there is a tapped union, which, when wiped on to the cable, overcomes the moisture difficulty. The face of the lid being machined, and having a red-lead joint, is also an improvement. This box, if filled with good solid compound, has a longer life than the first, but in overcoming the water difficulty others more serious have been created. As the joint has to be made with the box in position, it cannot be done on "live" cables; this defect is sufficient reason for its rejection, as in these days with the development of the day load this failing cannot be overlooked. Another defect is that the parts depend for contact on small set-screws, as with the box in position it is impossible to sweat the joints, even with the cable "dead." The fittings *may* be a good fit, but the chances are against this, and the best are made doubly efficient by sweating. Few engineers will tolerate unsweated joints in accessible places, and yet at the same time many consider them good enough to put away in the ground, often to the detriment of the net-work.

Enough has been said to show that the iron-box is undesirable for concentric jointing, and it now remains to be seen whether the lead-wipe box overcomes all defects, and has the many advantages claimed for it.

The essential points in an efficient joint-box are, briefly:

(*a*) It must be capable of keeping out water independent of compound, &c.

(*b*) Should be designed for manipulation on "live" cables.

(*c*) Must give facilities for sweating all inside connections.

The lead-wipe system has all these advantages, and is well adapted to all requirements. In addition to the single cable-joint already described, it can be used on any

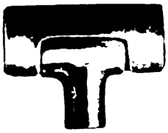


FIG. 1.

FIG. 4.

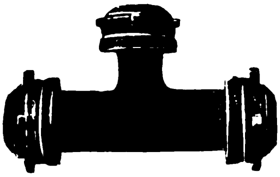


FIG. 2.

FIG. 3.

FIG. 5.

FIG. 6.

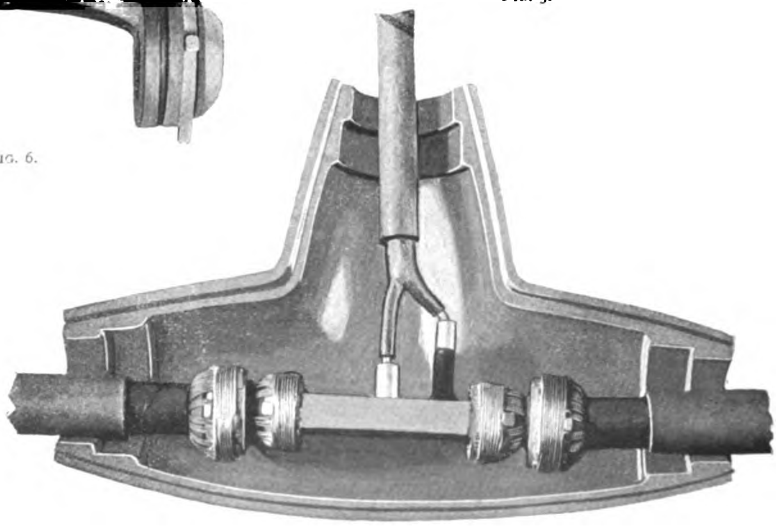


FIG. 7.

FIG. 9.

FIG. 10.

combination of tee, or straight joint, including concentric, triple-concentric, twin, or three-core cable.

In preparing a triple-concentric main, for a triple-concentric house service, the lead is cut off to the required length, the outer insulation is then "stepped" in the usual way each side of the cut, the lead is taped for about six inches with an inexpensive tape, to provide temporary insulation for the outer conductor, which is then severed in the centre, turned back, and covered with tape. Then the insulation is taken off the next conductor, which is cut, turned back, and taped as before. The insulation is then cut off the core to fit clip-tee (Fig. 1), which, after being fitted to core of house-service cable, is fixed on to main, the two halves being held together by means of two lugs at each end, which are easily gripped into position with gas-pliers. After this it is sweated and taped over. The next fitting (Fig. 2) is then placed in position, the bar being on top of cable. This is a specially shaped tee-bar with split collars at

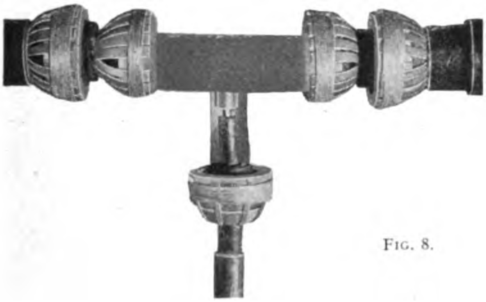


FIG. 8.

each end and on tee, each collar having a groove around its circumference to take copper-wire "binder" to hold the two halves in position. The collars are slightly tapered, and at extreme ends have four small studs to form shoulder for binding. After the conductor has been neatly placed around collar it is bound tightly with tinned copper wire, commencing from studs. After each end and tee have been arranged in this manner the whole is sweated and taped. The operation is then repeated with the outer fitting (Fig. 3), the bar in this case being underneath. The lower half of lead-box (Fig. 4) and the upper (Fig. 5) is then placed in position and wiped first along sides and then the ends, after which the box is filled with compound, the pouring-in holes capped up with lead discs and wiped, and the whole filled in solid with the cable.

In the case of concentric tee only, off triple-concentric, the conductor not required to be teed is joined with straight bar (Fig. 6). A very neat and economical joint for house service is the twin tee (Fig. 7). A concentric tee-joint without lead-box is shown in Fig. 8, straight joint-bars are shown in Figs. 9 and 10. This joint is suitable for all sizes and makes of cable, particularly the copper strip peculiar to the concentric cable of the "B. I. W. Co.'s" make, the flat strip making a very neat finish (*see* Fig. 8), and with this system of jointing is seen at its best. There is one advantage in this joint which will be appreciated by mains engineers generally; if the tee has to dip or rise to clear an obstacle, it can be made at any angle, thus overcoming that very objectionable practice of making sharp bends in cable, invariably necessary with iron-boxes. The writer would commend this joint to all advocates of a *perfect* solid system, as being much smaller than the iron-box it can be troughed in and filled solid with cable. The bitumen is also solid and continuous from one disconnecting-box to another, making it a solid system in *fact*, not in name only.

If the solid system has the advantages claimed for it, why not adopt an imperishable one? The old fallacy of the *cheap* wood-trough, with its superficial coat of Stockholm tar, should be known at its true worth by this time. Its weaknesses are many, the trough with the wood bridges, as they get wet and rot, introduce the very difficulties they were intended to overcome, considering that the bridges represent seven yards in a hundred, 7 per cent. of the lead of the cable is unprotected. The remedy is not to be found in making cable *without lead*, but rather by keeping to the lead covering and protecting it.

An ideal solid system for any kind of cable, which is imperishable in any soil, and costs about the same as wood-trough, the labour also being about equal. This consists of a U-shaped earthenware trough, with spigot and socket, the cables being supported on *bitumen* bridges. A tool can be obtained by which a labourer can make these at the rate of three thousand per day at *one-tenth* the cost of wood. There is not the least doubt about the efficiency of this bridge; the writer has some that have been underground over eighteen months, and they are perfect in shape, quite embedded in the bitumen, which was poured in hot. The hot bitumen uniting with the bridge forms a uniform covering all round the full length of the cable. A more expensive bridge may be obtained, but not a better one.

This lead-wipe system is no untried novelty, but has been in use under varying conditions for upwards of six years on an extensive net-work, during which time more than ten thousand (10,000) have been used—on all sizes and classes of cable—and not one "fault" has developed through moisture. Only two were traced as due to defective jointing and other causes, whilst at the same

time the average annual crop of iron-box "faults" have come along as usual. The above figures are conclusive proof of the superiority of the lead-wipe box over the obsolete iron-box for underground joints, especially as they are used under identical conditions. In the next issue the author will deal with disconnecting-boxes and the fusing of mains. (*To be continued.*)

Notes on the Working of Central Station Plant.—III.

By F. H. CORSON.

(*Continued from page 94.*)

Further Boiler-House Notes.

THE following article consists of a few more or less disconnected notes suggested by a series of tests on various sections of the steam generating plant, and the arrangement of which in any definite order is difficult, owing to the fact that such tests are individual in their nature and undertaken solely with regard to the particular object in view at the time.

Reference has previously been made to the number of stand-by boilers kept under steam, as a tribute to the poor load factors which obtain in most central stations, and the most advantageous method of maintaining these now calls for consideration. Two points arise in this connection :

(*a*) Whether the boilers shall be left coupled to the main steam range, and consequently at working pressure, or whether they shall be shut off ; (*b*) Whether, if shut off, their steam should be maintained at a high or low pressure.

Regarding the first question, the advantages derived from shutting off the boilers will in most cases be found to outweigh any conflicting considerations. The boiler steam valves will by this means be kept in good working order, and can be relied upon in any contingency, instead of becoming stiff and possibly leaky by long disuse. The amount of coal used to maintain the steam against condensation losses can also be easily determined, and any increase of this amount is at once evident and its cause can be ascertained and removed, while any suspected leakage of water from the boiler can be at once verified. If the boilers are not shut off when out of service, it is difficult to say whether they are generating steam or taking steam from the working boilers, and also whether a slight fall in the water-level is to be accounted for by evaporation or leakage.

The second point as to the best pressure at which to bank the boilers is less easily decided, as the arguments for high and low pressures are somewhat conflicting. On the one hand, the maintenance of steam at a high pressure implies relatively greater radiation losses, which are to some extent reduced by lower pressure and temperature, but on the other, the generation of steam to replace that condensed is more economically effected at high temperatures on account of the reduction of the latent heat of steam with increase in temperature, and proportionately less coal is required. It is comparatively easy, however, to determine the most suitable pressure by trial. The draught should be reduced to its lowest possible limit consistent with keeping the fires burning, and the amount of coal used for varying pressures can be found by experiment. Much of the waste of coal which accompanies the banking of boilers may be traced to the employment of excessive draught for this purpose, and considerable losses are incurred by want of attention to this particular with both working and banked fires.

In many stations it is customary to regulate the draught at the boiler-dampers only, a plan which is satisfactory as far as the working of the boilers themselves is concerned, but which leaves much to be desired on other scores. A better method is to check the draught by the main flue dampers nearest the chimney and to keep the boiler dampers wide open, using them merely as secondary regulators. By this means any leakage of cold air into the main flues, on account of shaken brickwork, badly fitting dampers or other causes, is reduced and the draught at the chimney is naturally materially improved. In this way, too, a single draught gauge placed on the main flue will allow of a much more convenient regulation than can be obtained by the measurement or estimation of the draught on each particular boiler.

An item in connection with the use of mechanical stokers which will amply repay investigation is the amount of steam consumed by the steam jets, used either for creating draught or cooling the bars. In the case of four makers of stoker investigated by the writer, this amount has proved to be between 9 and 14 per cent. of the output of the boiler, thus representing a considerable loss. The employment of the steam jet for this purpose is in itself very wasteful, and the jet pipes and their connections should be made sufficiently small to ensure that the absolutely necessary amount of steam cannot under any circumstances be exceeded, however carelessly the apparatus may be used. Unless the jets prove necessary, as shown by the over-heating and clinkering of the bars without them, they should be entirely dispensed with, as they involve a continuous drain on the economy of the boiler.

The question of superheat has latterly engaged considerable attention, and it is

interesting to observe the number of widely different estimates arrived at by equally reliable authorities as to the economy to be obtained from varying degrees of superheat. All station engineers are familiar with the tables which appear in print from time to time, prescribing a definite percentage saving in steam consumption for every increment of the superheat.

The writer is very loth to say anything depreciatory of the results of such tests, as there can be no doubt that the spirit of inquiry prompting such investigation is the most influential factor in promoting increase of knowledge and consequent improvement, from both the financial and engineering aspects, in the generation of electrical power. Such tables, however, must be somewhat unreliable, simply because of the danger of generalising from special results obtained under special conditions. The variation in economy achieved will be found to be as wide as the number of types of engine on the market, and this is obviously only natural, considering the influences at work in the employment of superheat. The first effect of increase of temperature is expansion and consequent distortion, if the working parts are not free to expand equally in all directions. The extent to which this expansion is restricted is a measure of the amount of increased friction involved, and all types of engine, with the exception perhaps of one well-known make, are so designed as to prevent equal expansion of parts at the same temperature. The increase in the interval friction of the engine is entirely dependent on the design, and obviously the same results cannot be expected from different designs. It is, however, established beyond dispute that for most engines the employment of superheat is accompanied by a considerable economy. The suggestions advanced in these notes on boiler house management are selected as being representative of the methods to be applied in dealing with the points at which the most obvious and regular losses occur. The intention has been to demonstrate that nothing short of the most careful investigation into every detail, in connection with the working of steam boilers, can give those good results which are desired in every type of factory, but which are of enormous importance to the financial success of electrical power generation. Every installation presents its own problems, other than those touched upon, the treatment of which will have its due effect in making or spoiling the work's records, and it is to be regretted that the boiler house, which is the department in which more than half the cost of generation is usually incurred, should have had such scant attention as has been the case in many central stations.

MECHANICAL v. HUMAN STOKERS.

In view of Mr. Whysall's recent articles, the following, taken from the National Electric Light Association, is of interest. Mr. E. Yawger, in a paper on the above subject, says:

"There is another phase of human natur that has an important bearing on the comparison of hand and machine firing which probably furnishes the stoker manufacturer with his strongest argument in favour of the superior fuel economy of the mechanical stoker. It is the well-known fact that there is a wide variation in the efficiency of individual firemen in the actual manipulation of the fires. During the World's Fair I was called upon by the judges to conduct some comparative economy tests on traction engines, for the purpose of determining the fuel economy of boilers and engines combined, when running at constant load, the furnaces being fired by the manufacturers' expert firemen. In five engines tested there was a variation in results of about 15 per cent. The steam distribution and the furnace and boiler design were quite similar in all five engines, and it would be safe to assume that their inherent efficiencies would not vary more than 5 per cent. The further difference, therefore, of 10 per cent. should be charged to the variation between expert firemen. One universal result of the substitution of mechanical for manual methods consists in a greater uniformity of product, and from the nature of the operation it is possible to maintain a stoker at or near its highest efficiency. To obtain this very desirable condition it will be necessary to start right by making a competent engineer responsible, not only for the selection of the machine, but for the unity of design of the entire furnace, from ash-pit to top of chimney. The responsibility is often assumed by stoker builders, and some of them refuse to make an installation unless full and satisfactory information is furnished covering all the essentials of the furnace.

"To maintain a boiler plant at its highest efficiency is not a complex problem, but it requires constant and intelligent supervision. It is its capability of responding to intelligent supervision that renders mechanical stoking superior to the human kind. The functions of the machine are varied, when necessary, by positive adjustments, and changes in adjustments can be governed by definite rules easily within the comprehension of the dullest operator. Any chief engineer of a station who himself is capable of operating successfully a mechanical furnace can, with a reasonable amount of attention, secure uniformly good results throughout a large plant."

CENTRAL STATION NOTES.

Insulation Test of a Dynamo by a New Method.

A periodical inspection of the insulation of generators and mains is necessary in every installation whether large or small, not that any importance attaches intrinsically to the numerical values indicated by the testing apparatus, but because the detection of any small change may be the means of avoiding an imminent breakdown. Ohmmeters and other special and costly apparatus find as a rule no place in small concerns, where it is more customary to employ a method known as the "voltmeter" method which dispenses with any instrument other than the plant voltmeter, and which consists in connecting the terminals of the generator under load successively to earth through this voltmeter, readings e and e^1 being taken. Then the insulation resistances of the conductors connected to each terminal are respectively :

$$R_1 = \frac{2[E_1 - (e+e^1)]}{e^1} \quad \text{and} \quad R_2 = \frac{2[E - (e+e^1)]}{e}$$

where r is the voltmeter resistance and E the supply voltage. This method is only applicable when all the apparatus on the line, lamps, motors, &c., and the generator itself are completely insulated, failing which very misleading results are obtained. A wise precaution is therefore first to test the dynamo and to allow for its insulation when the whole plant is being tested. For this preliminary step, the writer recommends a method which he saw in application at the Central station of Nancy, during the trial of a 600 k.w.t. generator, and which he will proceed to describe and explain briefly, from data supplied to the engineer in charge and inventor, M. Weber.

The load is taken off, and one brush of the dynamo, which is kept running, is connected to earth through an aperiodic direct-current voltmeter, reading e being taken. Then if E be the generator pressure and r the voltmeter resistance, the insulation resistance R of the dynamo $= \frac{E_1 - 2e}{2e}\, 2.$ For if ρ_1, ρ_2, ρ_3, &c., be the insulation resistances of each section of the generator, so that

$$\frac{1}{R} = \frac{1}{\rho_1} + \frac{1}{\rho_2} + \frac{1}{\rho_3} \text{ \&c.,}$$

each of these is subjected to a variable and undulating pressure whose extreme values are e and $E - e$ and whose instantaneous values at any moment can be expressed as

$$E1 = \left(\frac{E_1}{2} - e\right) - \frac{E_1}{2} \sin (2\pi nt - \phi),$$

where n is the frequency of the current in the section and ϕ the relative angle of position of each. Thus the leakage current through the insulation of each section can be put in the form

$$i = \left[\frac{E - 2e}{2} - \frac{E_1}{2} \sin (2\pi nt - \phi)\right] \frac{1}{\rho} \qquad (2)$$

and the voltmeter, through which these currents return partly is traversed by

$$i = \Sigma_1\, i\rho = \Sigma_1 \frac{E - 2e}{2\rho} = \Sigma_1 \frac{E_1}{2\rho} \sin (2\pi nt - \phi) \quad (3)$$

which is also undulating. But the voltmeter is aperoidic and designed for direct current, so that n is sufficiently great not to disturb it and consequently :

$$\frac{e}{r} = \Sigma \frac{E - 2e}{2\rho} = \frac{E - 2e}{2} \Sigma \frac{1}{\rho} = \frac{E_1 - 2e}{2} \frac{1}{R} \qquad (3^1)$$

$$\text{or} \quad R = \frac{E - 2e}{2e}\, n \qquad (4)$$

which relation of course only holds good when the conductors connected to the terminals, brushes and field magnet are well isolated. When another fault exists outside the armature (3^1) changes to

$$\frac{e}{r} = \left(\frac{E_1 - 2e}{2}\right)\frac{1}{R} + \frac{e_1 - e}{X} \qquad (5)$$

where e is the continuous pressure between the faulty point and the brush connected to the voltmeter, and X the resistance of the fault. By reconnecting this to other brushes, a deviation e^1 is observed such that

$$\frac{e^1}{r} = \frac{(E_1 - 2e^1)}{2} \frac{1}{R} + \frac{E_1 - \rho_1 - e^1}{X} \qquad (5^1)$$

Combining (5) and 5^1) one gets :

$$\frac{e + e^1}{r} = \frac{E_1 - (e + e^1)}{R} + \frac{E_1 - (e^1 + e)}{X}$$

and the total insulation resistance of the generator is :

$$\frac{1}{\left(\frac{1}{R} + \frac{1}{X}\right)} = \left[\frac{E - (e + e^1)}{e + e^1}\right] r$$

it being impossible in this particular case to separate R from X. But an idea can be gained of the importance of X by successively connecting the two terminals to earth through the voltmeter and noting $e - e^1$ which when X is infinite = 0. It may be of interest to determine whether the fault is localised or equally distributed among the several sections. In the latter case the expression

$$\Sigma_1 \frac{E_1}{2e} \sin (2\pi nt - \phi)$$

in (3) is zero for reasons of symmetry, *i.e.*, a hot wire or electromagnetic voltmeter shunted on the original instrument will give the same indications, whereas in the former case these would differ.

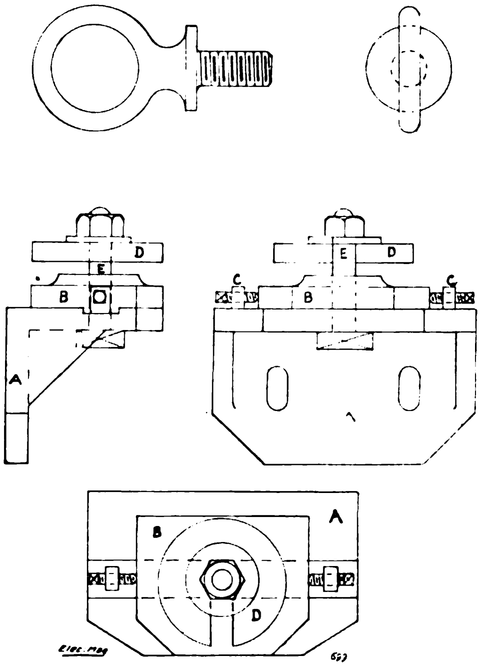
Once the insulation of the generator ascertained, that of the whole network and of all the apparatus on the line can be determined step by step ; but the insulation of each terminal with regard to the earth can only be ascertained accurately when that of the generator itself is known to be perfectly sound. The above method may be of use not only in small plants but also in large installations when it is desired, for instance, to test the insulation of a generator while in motion, and the results obtained are of the same order as those given by an ohmmeter.

Electrical artisans should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles on subjects of importance to themselves.

Rig for Screwing Eyebolts.

THE adjoining sketches show a rig for turning and screwing eyebolts for lifting dynamo magnets, motors, &c. It will be seen that the eyebolt has a shoulder or collar which serves to screw tight up against, and therefore against, and therefore needs to be faced square with the shank which is also turned and screwed its entire length; the rig is used on a hexagon turret lathe in the following manner. The chuck of the lathe is taken off and a face-plate substituted for it. The main casting A which takes the form of an angle-plate, is bolted to it very securely in such a position that the eyebolt when put in the rig is exactly in a line with the centre of the lathe spindle vertically, two square-headed set-screws shown screwed through the blocks C being used for adjustments in a horizontal direction. The blocks C are wrought-iron and secured into the angle-plate, which is planed on the top with a groove across the whole width about three inches wide. Into this groove a tongue on B fits, which keeps the latter in adjustment. B is turned on the top to a shape which allows it to fit into the eye of the eyebolt to be turned and screwed. This is slotted and tightened down by the bolt E, which passes through the whole piece, a slotted hole being cut through A for this purpose to allow for adjustment, and a round hole in B. D is a wrought-iron plate or washer for holding the eyebolt down, and has a slot cut to the centre as shown in the plan. This allows it to be taken off the bolt when the nut is slackened without taking the latter completely off, and thereby losing time. The eyebolt can then be lifted off the fixture and another put on. D is then slotted back on the bolt and tightened down, when all is ready. Fifteen per hour can be done by a youth using this fixture which formerly took half an hour each on an ordinary engine lathe.

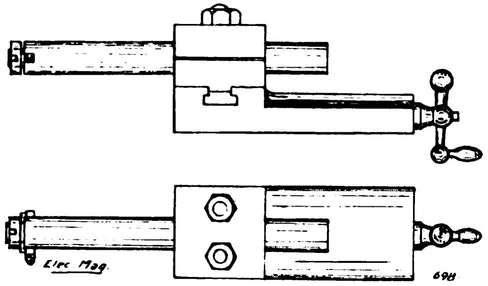
W.D.



SKETCH SHOWING EYEBOLT RIG.

BORING BAR FOR THE SLIDE REST.

THE sketches show a boring bar for use in the slide rest. It is very handy for boring brass bushes for dynamo and motor armature shaft bearings, being much more rigid than a square tool held in the tool-post. The tool-post is removed and two cast-iron blocks substituted for it as shown, held down by two bolts. The hole is bored out, with a bar mounted in the lathe-centres to ensure true alignment, and a light cut is afterwards shaped off across the joint of the top block

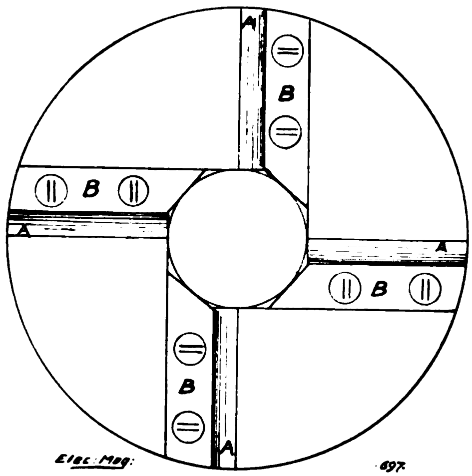


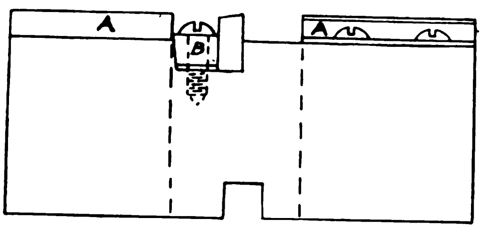
BORING BAR. BAR FOR SLIDE REST.

which allows for gripping the bar ; if preferred, split bushings can be inserted between the blocks and bar to allow of different sized bars being used ; square or rectangular-shaped cutters can be used, and are held tight by a round nut screwed on the reduced end of the bar as shown. They have been used with great success and are a great improvement over the ordinary type. W.D.

FACING CUTTER WITH INSERTED BLADES.

IN the sketches is shown a facing cutter with inserted blades which may be used to great advantage for facing up the ends of bearings which require a perfectly straight face. The body for holding the blades is made of cast-iron, turned all over, and bored a nice sliding fit on the boring bar it is intended to be used on. Four grooves are cut across the face as shown for the cutters, the front edge of groove being central with the hole, and the back edge extending to the outside of the hole, shaped 5 degrees taper, to suit the wedges which do not go to the bottom of groove within one-sixteenth of an inch, this being left for tightening up by the two small screws which hold the cutters firm in position. The groove cut across at the back is three-eighths of an inch wide by half an inch deep, and slots on to a peg, or ordinary boring cutter in the bar for driving purposes. It is better to fetch the outside scale off with a common serrated cutter and used the one in question for finishing only. The blades are all ground dead level on a Cincinatti grinding machine.

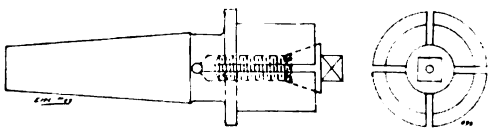




FACING CUTTER.

EXPANDING MANDRIL FOR TURNING BRASS BUSHES

THE accompanying sketches show an expanding mandril which is used with great success for turning brass bushes for motor shaft bearings on, after they have been bored in the lathe ; it fits in the centre hole of the fast headstroke, as will be seen, and takes the place of the ordinary centre. The front end is bored out to receive a half-inch set-screw, as shown, with a taper on the outer end. It



EXPANDING MANDRIL.

is afterwards slit across at right angles with a milling cutter. When the setscrew is screwed tight up it expands the front end of the mandril and grips the work tight. It can be made without the collar if preferred, so that a facing tool can be used at both ends at the same time. With a set of split bushings different sizes of work can be gripped. It is very much quicker than driving mandrils in and quite rigid. SWIFT.

***This section** is run entirely in the interests of artisans, who are cordially invited to contribute to it anything in the shape of notes, sketches, &c., directly bearing on some electrical or mechanical portion of their work. These are paid for at special rates, and will always be carefully considered.*

ELECTRICAL TRADE and COMMERCE

Trade and Commerce Articles of the month are classified under the World's Electrical Literature Section at end of Magazine.

Report of the Tariff Commission.

By W. N. TWELVETREES, M.I.Mech.E., A.M.I.E.E.

WHATEVER may be the opinions entertained with regard to fiscal reform, it must be admitted that the work accomplished so far by the Tariff Commission is worthy of all commendation. This body, representing all shades of political thought, is also representative of all the great industries of the United Kingdom. The volume now issued relates exclusively to the iron and steel trades, and contains a large number of typical extracts from the replies of various firms to the forms of inquiry, and a full summary of the evidence given by witnesses before the Commission. The truly representative character of the information obtained is shown by the fact that while the total number of persons employed in the industries is about 265,000, the number employed by the firms answering inquiries is no less than 230,986, or more than 87 per cent. of the total number. In this note we do not propose to quote any statistical data *in extenso*, as these can be studied more conveniently from the Report itself. But we may usefully point to some conclusions to be drawn from the facts. So far as pig-iron is concerned it is shown that during 1876-80 the production of this country was 55 per cent. greater than the combined output of Germany and the United States and nearly half the total production of the entire world. In 1903 the output of the United Kingdom was less than that of Germany, less than half that of the United States, and less than one-fifth that of the world. In the case of steel we find that while in 1876–80 the output of this country was one-third that of the entire world, the proportion fell in 1902 to one-seventh. The relative decline thus indicated is further confirmed by the replies of firms actually engaged in the industries, and much information is given that demands the most earnest consideration of all who have the welfare of the country at heart. The continued severity of foreign competition, the substitution of foreign for British-made products in the home market, the loss of foreign markets, and increased competition in colonial markets are features brought prominently forward by the evidence now available. Various reasons have been suggested from time to time to account for the unsatisfactory condition of British iron and steel industries. Many of these are quite wide of the mark, and we believe that careful perusal of the Report will convince all reasonable men that the true cause is to be found in the carefully organised export systems of foreign nations, who avoid Free Trade except to use it as a weapon against the United Kingdom. In the chief iron-producing countries of the world the home markets are controlled by the aid of protective tariffs, bounties and preferential rates are provided for exporters, and trusts control the operations of manufacturers so that the home markets may be secured and British markets successfully attacked. Dumping is practised on scientific lines, and in such a way as to kill all fair competition. When assisted by an absolutely controlled home market, the exporter can not only sell goods below cost price but can afford to do so, because the increased turnover helps to keep down the cost of production, and the home market more than makes up for any loss that would otherwise ensue. For a full account of the methods now directed against British trade, we must refer our readers to the Report itself, and we feel sure they will come to the conclusion, also reached by the Commission, that effective retaliatory measures are absolutely essential if the great iron and steel industries of the United Kingdom are to be preserved. We are now face to face with new conditions. The whole world is protected against British competition, and is armed to war against British trade. At present our iron and steel industries are the

defenceless prey of the foreigner—a fact that should fill the most ardent Free Trader with dismay.

GENERAL TRADE NOTES.

St. Louis Exposition—A Useful Guide.

An interesting pamphlet, containing much information relative to the St. Louis Exposition, has recently been published by the Westinghouse Companies. All the chief features of the exposition are shown on a clearly coloured map, and an index gives the position of all the Westinghouse installations, and all other exhibits which are of interest to engineers. Another index gives some representative Westinghouse installations in the town of St. Louis. The machinery and transportation, and the electricity and machinery buildings contain the most important exhibits of these companies, whose exhibit area, excluding the service plant, extends over an area of 39,000 sq. ft., or, including the service plant, 66,000 sq. ft.

Extension of Supply Mains at Southampton.

It is proposed to extend the mains and house services of Southampton, and for this purpose the Town Council are making application for a loan of £2000. The loan of £2288 has already been sanctioned for the electric lighting of St. Mary's Road and for laying new mains in two other streets. It has been recommended by Mr. H. F. Street, the electrical engineer, that the number of arc lamps in the different streets should be augmented by twenty-eight additional lamps, and a memorial is being prepared asking the consent of the Board of Trade to the laying of mains and house services in streets not kept in repair by the Council, so that as the demand for current arises the Council may be in a position to undertake the works necessary to provide for the supply to consumers.

Exports of Telegraph Cable.

The cable export trade for the month of May shows, as usual, very varied returns. During that month the shipments were the largest this year, amounting to £171,760, those for April being only £45,249; a satisfactory increase is also shown over the shipments for May 1903, when the total was £100,392. On the whole, however, the total value of telegraph cable exported during the first five months of the present year has been considerably less than the amount exported for the same period last year, the totals from January to May being £461,025 for 1904, as against £1,362,133 for 1903.

Electrical Machinery for Bombay.

We learn from *La Metallurgie* (Paris) that there will shortly be a great demand for electric ventilators and other electrical apparatus in Bombay. At the present time hardly any of these articles are stocked in the city, as generating stations are few and far between. A station is, however, being erected by the municipality of Bombay for the distribution of electric light and motive power, and a good opening for electrical apparatus will thus be created. It is also stated that Bombay supplies Arabia largely with machinery, more especially with pumps and apparatus for boring wells. This machinery has to be carried a long distance on camels, and it is advisable to construct it so that it may easily be taken to pieces; in cases where this is impossible the machinery should be of a very simple and light nature.

Electrical Appliances in Russia.

There is always a considerable field in Russia for all electrical appliances, and in the future the demand will probably become far greater. No official returns of the import of such manufactures are available, but we understand that Germany has the largest share, believed by competent judges to be about 80 per cent. of the total imports. The tramway systems of various cities have already been converted, and others are now being converted to electric traction. Electric light plant is being installed in different parts of the country. Last year the Moscow authorities commenced the conversion of the tramway system, and a considerable part of the work has already been done. It is reported that the undertaking will not be completed in less than five years, as the long winter season considerably curtails the number of working months.

The Electrical Industry in South Africa.

Numerous installations of electrical plant are now being carried out in South Africa, and various plans for large electric lighting schemes and the electrification of tramways are likely to be brought under consideration very shortly. The number of electric light installations has very much increased, and many of those already in existence are being considerably extended. It is stated that generating plants in many South African towns are now regularly kept running night and day—a fact which clearly demonstrates the growing needs of the country; and it is expected that this branch of industry will exhibit still further expansion within the next few years.

Openings for Trade in Victoria.

The Canadian Commercial Agent at Melbourne reports that there is every probability of a demand shortly taking place for hot-water and steam radiators, and warm-air furnaces. Last winter the two principal theatres in that city were heated for the first time, one on the radiator principle and the other by electricity, the latter, however, not proving very successful. These are the only instances in which an attempt has been made to heat places of amusement in Victoria. The large number of halls, churches, and other buildings throughout the State are absolutely without heating appliances. Complaints appear from time to time in the Press concerning the cold experienced in these buildings. Hotels and office buildings have only open fire-places or very indifferent and objectionable gas-stoves. The Victorian winter extends from about May until the end of September. There seems to be an opening for an energetic firm to make an effort to place their manufactures on the Victorian market, and to educate the people in the use of modern heating appliances. To success

fully introduce these appliances would require the services of an expert in the business, fully qualified to sell the goods and attend to their installation.

Electrical Trade in Canada.

In a paper recently read before the Canadian Electrical Association, Mr. Johnson, the Dominion statistician, stated that there were in Canada forty-six street railroads, with 455 miles of track, capitalised at about 30,000,000 dollars, while in the United States similar lines aggregate 25,800 miles of track, capitalised at 1,630,000,000 dollars and carrying about five billions of passengers per year. In the year 1903 there were 324 light and power companies in Canada, employing nearly two thousand hands, and with an invested capital of 20,000,000 dollars. The number of arc lights in the same year amounted to 14,780, and incandescent lights to 1,212,861. Ontario has a total of 203 plants in operation, but the largest proportionate increase in any province is shown by British Columbia. Mr. Johnson concluded with the remark that: "The electrical engineer is dealing with a force whose uses have become, and promise to become even more in the future than in the past, so varied that, more than any profession, a man has to be a hustler all the time or he will become a way-back, even while he is positive he is well to the front. The up-to-date man of to-day is rearguard to-morrow if he is not always on the alert, so rapid are the movements, so numerous the applications of the electrical forces."

Electricity in Mexico.

Marked progress continues in the development of the electrical industry in Mexico. Power will be supplied from numerous natural water-courses of the country, and it is probable that the Mexican Railway Company will decide to convert all its systems from steam to electric traction in the near future—a proceeding which will result in a great reduction in the importation of coal into the country. The Guadalajura and Morella section of the system is now about to be electrified, this portion being about 120 miles long. It is stated that much of the enthusiasm now existing among Mexican authorities in favour of electricity has been inspired by the United States.

Electricity in Malaga.

In the Chorro, near Malaga, a large electrical plant has been installed for the purpose of supplying Malaga and intervening localities with electric power for manufacturing and industrial purposes. The concession for a light railway from Malaga to Coin has also been granted, and in course of time this will be operated in connection with that from Malaga to Nerja in the opposite direction. These lines will open up various productive centres, facilitating the transport of minerals and other products to this shipping centre. The Malaga tramways have hitherto been worked with horse-traction, but it is now proposed to utilise electric power, first in the suburban connections and later throughout the system, should the experiment give satisfactory results.

New Central Station, Brussels.

The contract for constructing and equipping a large central station at Brussels which has lately been the cause of so much competition between Belgian, German, and French groups has now been finally given by the municipal authorities to the Berlin Allgemeine-Union Company, which company is represented in Belgium by the Société Belge d'Electricité A.E.G. of Brussels, and the Union Electrique of Brussels. The contracts for the machinery and buildings amount to £23,616, and to £51,400 respectively. among the unsuccessful competitors were the Lahmeyer Company, the Parisienne Electrique, and two Belgian companies. The contractors have undertaken to furnish a supply of current by the end of this year, and a regular supply for the winter of 1905, the date fixed for the final completion of the works being October 1906.

New Generating Works at Chicago.

From a recent consular report we learn that electric power generating works are being established on the Chicago drainage canal at Lockport for the purpose of utilising water flowing from Lake Michigan and the Chicago River to the Mississippi. The river and the canal already afford facilities for moving both raw and manufactured material, and when the electricity works have been completed these waterways will afford power for running the works built on their banks. It is hoped that the undertaking will be completed in about five years, and Chicago will then have a still greater attraction for manufacturing industries. It is also stated in the same report that the manufacture of electrical supplies in St. Louis has been rapidly developing, and in the next decade this city bids fair to become one of the largest distributing points for the West. The sales for 1903 amounted to about £1,400,000, exclusive of the large amount in use by the Louisiana Purchase Exposition.

Burton—Ashby—Swadlincote.

The Midland Railway Company have entrusted Messrs. Dick, Kerr and Co., Ltd., with the contract to construct rather over ten miles of light railway, linking up Burton-on-Trent, Ashby de la Zouche, and Swadlincote. The main roads are being followed with the exception of a short length where sleeper construction will be used. The work will be carried out to the drawings and specifications of Messrs. Chas. H. Gadsby and Co., the company's engineers.

Industrial Development in Italy.

Great advances continue to be made in Italy in the manufacture of machinery, including boilers, pumps, turbines, electric and hydraulic cranes, lifts and hoists, motors and accumulators. The success of Italian manufacturers is largely due to the faculty they possess in so marked a degree for overcoming technical difficulties and for improving and perfecting recognised processes. This ingenuity is shown not merely by managers and foremen but also by ordinary workmen, with

the result that both the cost and quality of production are favourably effected. The sober and thrifty character of the workmen, the fewness of their wants, and the consequent cheapness of labour constitute a material factor in Italian industrial prosperity.

Raworth's Traction Patents.

We learn that the Electric Traction Company, of Havre, has decided to make trial of a car fitted with automatic regenerative control, thus making the eighth tramway company by whom the system has been adopted.

German Exports and Imports.

From recent returns it appears that exports of electrical machinery from Germany show an increase which is considered satisfactory in that country, the total exportation for the first three months of the present year having been 3,434 tons as compared with 3,026 tons during the same period of the year 1903. Very little increase has been evidenced during the same quarter in the already insignificant amount of electrical machinery imported into Germany, the figures being 156 tons in 1903 and 298 tons this year.

Electrical Progress in Egypt.

Striking evidence of the progress being made in the application of electricity in Egypt is afforded by the announcement that the Fayoum municipality has entered into an agreement with Mr. Clowes, Inspector of the Fourth Irrigation Circle, to utilise the Nazleh Waterfall for the generation of electricity for the lighting of Medivet-el-Fayoum. As the power thereby rendered available, estimated at 800 h.p., is far more than that required for the lighting of the Fayoum, it is proposed to make use of the surplus for the operating of machinery in cotton manufactories, corn-mills, and other industrial establishments. We have on previous occasions directed attention to the splendid openings for business now existing in Egypt, and we trust that manufacturers will not fail to profit by the scheme mentioned in the present note.

Proposed Electricity Works for Reichenburg, Austria.

We are informed that a central power and light station, the establishment of which has been under consideration for some time, is about to be installed in the Reichenburg district, the total supply area being about one hundred square miles. Exclusive of Reichenburg itself, this scheme will provide for the supply of current to at least twenty-four towns and villages, with a collective population of about 60,000 inhabitants. At present, the subscribed capital only amounts to £40,000, but it is expected that it will finally reach a total of £80,000. In addition to the supply of electricity for light and power to ordinary consumers, the installation and working of electric tramways are contemplated by the company. So far as Reichenburg is concerned, the supply of electricity is in the hands of existing companies, and it is possible that these undertakings may be acquired by the municipal authorities, negotiations which are now being conducted may, however, result in an arrangement more favourable to the prospects of the new company.

Electricity in Japan.

Among other new enterprises in the island empire, the following are worthy of mention: (1) A new tramway system in Tokio, which is to be operated by electricity generated by means of Curtis steam-turbines, orders for four 1,500 k.w. and two 500 k.w. units, together with switch-gear and 800 tramway motors, having already been placed; (2) An electric railway, 120 miles long, between Shiminoseki and Fusan, projected by the Sanyo Railway Company, which will involve the purchase of considerable quantities of electrical machinery and plant. This undertaking presents an excellent opportunity for enterprising British manufacturers. We also learn that a large quantity of rubber-insulated wire has recently been ordered, by the Government contracting firm of Oki and Company, of Tokio and Yokohama, from the Safety Insulated Wire and Cable Company, of New York.

The London Chamber of Commerce and the Electrical Industry.

Among various matters of more or less importance to the electrical industry considered at the last meeting of the London Chamber of Commerce, were the provisions of the Supply of Electricity Bill. This Bill was approved on the whole, subject to modifications in some points of detail. After discussing whether certain draft regulations, resulting from the report of the committee on electricity in mines, would affect the electrical industry as a whole, it was decided by the Council of the Chamber that the matter should be brought before the notice of the Home Office, with the request that any proposed regulations under consideration might be referred to the Chamber so that the electrical section might have an opportunity of communicating their views to the Home Office before the final settlement of the regulations. The following objections to the Supply of Electricity Bill have been formulated by the Chamber: (1) That it is unsound in principle that a great spending authority such as a county council should itself be the valuation authority; (2) That the bodies which control the assessments are themselves competing with traders; (3) That the valuation authorities will appoint expert valuers, and that there is no security under the Bill that the system of payment according to the amount of the assessment secured by their efforts will be discontinued; (4) That there is no machinery by which a ratepayer can appeal to a competent independent court. It was finally agreed that the different sections of the Chamber should unite to present their decisions before members of Parliament, and that the matter should be handed over for action to the General Purposes Committee.

ELECTRIC TRAMWAYS IN THE EAST.

It is satisfactory to learn that, despite the keen competition which exists in the East for electrical work, at least one English firm is able to secure large and inclusive contracts for electric tramways and lighting. Following up previous successes, Messrs. Dick, Kerr and Co., Ltd., have recently obtained a contract for electrical tramway plant for Bankok tramways owned by the Siamese Tramways Company, Ltd. The contract includes power-house equipment of three 200-k.w. 500-volt direct-current generators of Dick, Kerr's standard type coupled direct to three Browett Lindley vertical compound engines, and the usual accessories, including surface condensers, pumps, &c. There are also forty single motor equipments of Dick, Kerr's standard 25B type, mounted on Brill 21E trucks, and the whole of the rails, fishplates, tie-bars for the line, which has a total length of thirteen and a half miles. Of the other contracts which the same firm are carrying out, the Mandalay tramways have just recently been successfully opened by the Lieutenant-Governor of Burma, Sir Hugh Barnes, K.C.S.I., K.C.V.O., and the system is now in operation. The total length of the tramways is twelve miles of single 3′ 6″ track laid with rails of the girder type, weighing 85 lbs. per yard. The overhead equipment is on the span wire system, of a very neat and rigid design. The rolling-stock consists of twenty-four single-deck, open, cross-bench cars, to accommodate forty-eight passengers, built for Dick, Kerr and Co. by the Electric Railway and Tramway Carriage Works, Preston. The cars are mounted on Brill maximum trucks, each car being supplied with a complete electrical equipment consisting of two of Dick, Kerr's standard 25B motors with DBI-form "C" controllers. The power-house equipment consists of three Dick, Kerr's direct-current compound-wound 200-k.w., 400-r.p.m., 500–550-volts generators, direct coupled to three Belliss compound engines; the switchboard, which was built by Dick, Kerr and Co., is in accordance with the standard traction practice, and consists of four feeder-panels, three generator-panels, one testing-panel, and one panel for motor and lighting circuits.

The electric tramways of Hong Kong are rapidly approaching completion, the contractors again being Dick, Kerr and Co. The total length of single track is fourteen and a half miles, and is laid to a gauge of 3′ 6″ with girder-type rails weighing 86 lbs. per yard. The overhead line within the city is centre-pole construction, in the outskirts equipped on the side-pole system. The power-house is as nearly as possible in the centre of the system; the plant comprises two Dick, Kerr standard direct-current 300-k.w. multipolar railway generators running at 100 r.p.m., giving 500 volts, direct coupled to the main shaft of two engines built by Yates and Thom; in addition to the two traction sets, two combined sets for arc and incandescent lighting of the depôt have been installed. The switchboard consists of two generator-panels, two feeder-panels, three lighting-panels, one main station-panel, and one B.O.T.-panel. The boiler-house contains two Babcock and Wilcox water-tube boilers and the usual accessories, twenty-six single-deck cars are provided, ten being of the combined type with an enclosed portion in the centre and an open platform with seats at either end, and have a seating capacity for thirty-two passengers; the remaining sixteen cars are of the open cross-bench type, to seat forty-eight passengers, the cars were built for the company by the Electric Railway and Tramway Carriage Works, Ltd., Preston. Each car is mounted on a Brill 21E truck and is fitted with two 26 h.p. motors, and at either end of the car is one of the same firm's standard form "C" controllers. As this is the pioneer system of electric traction in China, it is to be hoped the venture will meet with a well-deserved success, and that electrically equipped lines will shortly be laid in other parts of the Celestial Empire.

Singapore tramways are in the hands of the same contractors, and the work is making considerable progress. The power-house contains eight Lancashire boilers, with the usual accessories, including two fuel economisers and four feed pumps, three engines, two of Yates and Thom's horizontal cross compound condensing type coupled direct to two 500-k.w., 100 r.p.m., 500-volt compound generators. For lighting purposes a 200-k.w. plant has been installed, including one direct-current generator of 150-k.w. capacity coupled direct to a Willans engine, also a 50-k.w. motor-driven generator working off a circuit of 650 volts. A suitable switchboard has been supplied and erected by the contractors. The overhead work has been carried out on the span wire system. The total length of single-track is twenty-seven miles, and is laid to a gauge of one metre, and the form of construction consists of laying girder type rails weighing 95 lbs. per yard upon a continuous beam of concrete. The rolling-stock consists of fifty cars, twenty single-deck, single-truck combination type, with a seating capacity of thirty-two persons, sixteen inside and sixteen outside; and thirty open cross-bench type, to seat forty persons. They are mounted on Brill 21E trucks, and equipped with 26B motors and DBI-form "C" controller. In addition, there are thirty-three goods-vans, mounted on Brill 21G trucks, each with a double motor equipment, the whole of the rolling-stock being built by the Electric Railway and Tramway Carriage Works, Preston.

Lastly, that most successful tramway owned by the Calcutta Tramways Company is carrying out considerable extensions, and this work has been entrusted to the original contractors, Dick, Kerr and Co., Ltd. This includes an additional ten open type motor-cars, in all respects the same as those supplied before, *i.e.*, single-deck open-type cars mounted on Brill 21E trucks and equipped with two 25A motors, each with a DEI-form "C" controller. The main station plant is being increased by one of Dick, Kerr's standard three-phase alternators, 500 k.w., 25 cycles, 6,000 volts, 94 r.p.m., direct coupled to a Yates and Thom horizontal cross compound engine, and the switchboard was also built by the same firm. There are two sub-stations being erected, in which will be placed one 300-k.w. rotary converter with the necessary transformers and switch gear, by the same contractors.

ELECTRIC FINANCE and Legislation

Gas versus Electricity.

By the ASSOCIATE EDITOR.

A COMMITTEE of the House of Lords, presided over by the Duke of Northumberland, has had the very difficult task of deciding the dispute between municipal electrical undertakings and gas companies competing in the same area, the dispute arising upon the introduction by the Board of Trade of two Bills to confirm several electric lighting provisional orders granted by the Board of Trade to certain municipalities and local authorities. The opposing gas companies endeavoured to secure the application of the "Bermondsey" clause, which was obtained in 1902 by the South Metropolitan Gas Company, who opposed the Bermondsey Borough Council when the latter sought to obtain an electric lighting provisional order; the clause thus obtained has been inserted in many provisional orders, usually by agreement, and in opposition to the wishes of the Board of Trade.

Municipal Sins.

THE facts placed before the Committee brought strongly to light the enormous losses incurred by municipalities in their electric trading undertakings, no less than 112 undertakings showing losses out of a total of 174, and the gas companies sought to restrain the local authorities from the present method of making good their trading losses at the expense of the ratepayers. The "Bermondsey clause" provided that the revenue for the year should not be less than the expenditure for that year, and it was assumed that this would cause the local authorities who were making losses to increase the charges for electrical energy.

It certainly does not seem fair or in the public interest that the authorities should systematically charge very low rates for electricity, and deprive the gas companies of their consumers and then have the advantage of obtaining financial assistance in the shape of rates in aid from the very people they have injured by such competition.

If the losses of the local authorities only extended to the first three or four years, the contention of the gas companies would be of less importance, but, unfortunately, they were able to refer to many undertakings which had been working in some cases ten years and were still requiring rates in aid to make up their losses.

Municipal Defence.

THE Hon. T. F. W. Pelham, Assistant Secretary to the Board of Trade, in his evidence, explained the difficulties involved.

The local authority had to erect substantial works, involving a large expenditure of capital, much of which is unproductive for some years, but the repayment of capital and interest must be provided which together would equal about 6 per cent., so that it was necessary to develop the undertaking for three or four years, and the Board of Trade thought it not unreasonable that the local authority should have a loss so that they might eventually gain.

Decision of Committee.

THE decision of the Duke of Northumberland's Committee was, we think, most reasonable, and will stimulate the local authorities concerned to conduct their undertakings upon proper business principles. The period of five years now permitted for the development of a new undertaking is amply sufficient, and also the period of three years for existing undertakings. The clause will not come into force unless a local authority makes an application for an extension of its area of supply, and this, we think, another good point, because it will deter those authorities who are seeking to enlarge their enterprises from so rashly extending their trading outside the boundaries of their own borough.

MUNICIPAL METHODS.

We understand that three syndicates have approached the Ripon Corporation to obtain their consent to supply electricity within the municipal area, such consent being necessary under the present laws, if Parliamentary powers are to be obtained by the usual means of a provisional order. The Corporation have thus been forced to consider the question of electric lighting, and now after years of inactivity are about to consider whether it would or would not be better to keep the electricity supply in their own hands. This is the usual attitude of municipalities, and is most certainly open to the strongest condemnation. They do nothing for years, and then when progressive steps are undertaken at the instigation of private enterprise they are by refusing consent able to keep out the private undertaking. This is usually done by applying for a provisional order themselves, which is invariably granted to the local authority in preference to a company. Having obtained the order, and being in possession of all the powers necessary to stop private enterprise, they usually find that the commencement of the undertaking involves a considerable amount of technical knowledge, which the directors of a company possess, but which in very few cases is possessed by the ordinary town councillor; consequently, the commencement is delayed, in many cases, the question is shelved, and the provisional order lies dormant for years. In this way the local authorities have done great injury to the whole electrical industry by retarding progress, and we think that the Board of Trade should compel the local authority to comply with the condition of the provisional order under which the works must be commenced within two years from the date of the order. Unfortunately, the Board of Trade do not press, and consequently many towns are without the advantages of electricity.

MUNICIPAL DEBTS.

At the second annual meeting of the Industrial Freedom League, Lord Avebury drew attention to the rapidly increasing indebtedness of local authorities, who, he stated, were more and more inclined to launch out into commercial undertakings, and a recent return showed that the outstanding loans of 319 municipal authorities in England and Wales amounted to £195,000,000, an increase between 1894 and 1902 of no less than £141,933,000. A resolution was passed urging the Government to carry into effect the report of the Joint Select Committee on Municipal Trading, and to appoint a Royal Commission to complete the work of the Committees of 1900 and 1903 by the issue of a report upon the whole question of municipal trading.

We hope that the Government will comply with this request and appoint a strong Commission to thoroughly investigate this question, which is of the greatest importance, and has, we believe, a direct bearing upon our industrial position. It should always be remembered that Parliament is responsible for the present position, it has sanctioned and assisted municipalities in their trading undertakings up to a certain point, but has inflicted restrictions which place the municipality at a decided disadvantage as compared with a company. It is now urgently necessary that the municipalities should be allowed to conduct their trading enterprises upon proper business lines, or to hand them over to companies, and we think that the latter course would be in the public interest. It cannot be seriously contended that the municipal control of gas undertakings has been successful, either in reducing the charge to the consumer, or producing a profit to the ratepayers commensurate with the risks incurred, and if such undertaking had been left in the hands of companies allowed by Parliament to pay only limited dividends we think greater progress would have been recorded and our previous financial position very much improved.

FINANCIAL NOTES.

L.C.C. and Charing Cross Station.

It is well known that the County Council is most anxious to bring its trams across some of the Thames bridges and connect up their North and South systems, but so far their attempts to obtain the necessary powers have failed. The latest proposal is sufficiently original to command attention and sufficiently grotesque, we fear, to create amusement. It is nothing less than to buy up Charing Cross Station and the railway bridge across the river, giving the railway company a site on the Waterloo side of the river, and using the bridge for tramways to join the two systems! We rather like that expression, "giving the company a site" on the South side. There is nothing niggardly here, no regard for cost or dimensions; nor is there any note of hesitation in this proposal to buy up the station and bridge. One might think that the Council was a fabulously wealthy body, with no limit to its income, but, unfortunately, we know only too well that its debt is already tremendous. We do not believe for a moment that such a scheme will ever be carried out, but the proposal is significant as indicating how far some members are prepared to go in their enthusiasm for tramway enterprise.

Tottenham Court Road Trams.

We have already commented on the L.C.C. proposal, brought forward again this year, to run tramcars across the Marylebone Road from Hampstead Road and down Tottenham Court

Road to Oxford Street. It will be remembered that in Committee of the House of Commons, part of this scheme was struck out owing to want of proper width between the side-rail and the kerb at a certain point, but powers were given to construct a line from the top of Tottenham Court Road down to this point, which is near Francis Street. To us, that appeared to be a wrong and unwise decision, as a short line of this kind for only half the length of the street would be worse than useless; and we are therefore glad to see that on third reading of the Bill this line was struck out entirely. There has been a good deal of talk in a certain section of the Press about this decision and even some of our electrical contemporaries have criticised it and expressed their regret. We are sorry to differ from them, but we regard this decision as extremely wise, especially in view of the fact that the Traffic Commission will report soon and will deal with tramways as well as railways. But apart from that, we look upon the attempts now being made to bring tramlines nearer and nearer to the heart of London as unwise, for nowhere do we have streets of proper width for these vehicles, and they therefore add to the congestion instead of lessening it. The Tottenham Court Road certainly strikes us as extremely unsuitable for tramways, and we confess we see no merit in this proposal.

A Ministry of Commerce.

IF recommendations of Select Committees and Royal Commissions were always accepted, we might expect soon to have a British Ministry of Commerce, as the Committee which has been considering the constitution and organisation of the Board of Trade has recommended that that body in its present form should be dissolved and that a completely organised Ministry of Commerce be substituted. Unfortunately, the reports in Blue-books are too often ignored; but we sincerely hope that this particular one may be acted upon. The Board of Trade undoubtedly does a vast amount of good work, but for modern needs it is not properly equipped. So far as the electrical industry is concerned, we have no serious fault to find with the *technical* department looking after electrical affairs. The staff is always willing to give assistance and is much more free from "red tape" than is usual in Government departments. But on the commercial side, there is great room for improvement. The *Board of Trade Journal* serves a useful purpose, so far as it goes, but it does not go far enough. For one thing, our Consular service is not taken advantage of sufficiently for the expansion of trade, and in this respect much may be learned from the United States. Our Board of Trade should be in a position to disseminate much more trade information than it does; but to be in this position it requires a much larger staff than it now has, and the head of the department should be more closely in touch with the commercial interests of the nation. It is not necessary that he should be himself a commercial man, for many commercial men are less qualified to take a broad view of trade in general than a man of highly trained intellect who may never have been engaged in trade. But he must be supplied with a completely organised trade bureau, and that we have not got at present. We therefore entirely approve of the proposal to create a Ministry of Commerce, with a place in the Cabinet for its chief, and we hope that ere long this plan may be adopted. We doubt if this is likely to be done immediately, as the present Government has many problems demanding its attention, but we should like to have a definite promise that ere long an attempt will be made to carry out this reform.

Fresh Capital.

THE extensions of the system of the Cambridge Electric Supply Co. have necessitated a large overdraft at the bank during the year, and this is now to be paid off by calling up £1 on each share, and by issuing £30,000 4½ per cent. debentures, of which only £15,000 may be called up during the year.

THE Tyneside and District Electric Traction Co. is extending its lines into fresh areas, and in the coming summer it expects to arrange for the construction and equipment of a light railway to Whitley Sands. Further capital is therefore needed, and 4,000 additional ordinary shares of £5 each will be issued.

THE preamble of the Bill promoted by the Baker Street and Waterloo Railway Co. has been passed by the House of Commons Committee, and we may therefore expect shortly to find a public issue of new capital for this line. The Bill asks for powers to raise £384,000 additional capital to carry out various improvements to make the line of the greatest possible use to the public. New stations will be constructed at Kennington Road, Regent's Park, and Edgware Road. The line between Baker Street and Waterloo is expected to be open for traffic in about eighteen months.

TRAMWAY NOTES.

Birmingham Running Powers.

As a contrast to the action of the Newcastle Corporation, it is pleasant to find that the Birmingham Corporation has made an agreement with the Aston Corporation and the latter's lessees of the tramways by which it is now possible for cars to run through from Aston to Birmingham. Formerly, a change of cars was necessary at the city boundary, and this caused great inconvenience to the public. Under this new agreement, the service of through-cars will be temporarily worked by Birmingham, which will hand over to Aston all the profits made in Aston, less working expenses. The basis of division of receipts is that Birmingham reserves to itself 5 per cent. of the fares, as being in respect of city passengers exclusively, while of the remaining 95 per cent. four-fifths go to Birmingham and one-fifth to Aston. The agreement is for two and a half years, but at the end of twelve months either party may demand a revision of terms. The Birmingham Corporation cars will alone give the service until the company to which the Aston Corporation has leased its tramways has completed its depôt and is ready to run its cars. We feel sure that this arrangement will be profitable to all parties, and it will be welcomed by the public.

COMPANIES' REPORTS.

General Electric Company.

THE report for the year states that the net trading profits amount to £83,864. The dividend for the year on the ordinary shares is 7 per cent., and £20,055 is added to the reserve.

The Witton Engineering Works and Foundry are now in fine working order, and the Company has many important contracts in hand.

Buenos Aires Tramways.

AT an extraordinary general meeting of the Anglo-Argentine Tramways Company, Ltd., it was resolved to purchase the city of Buenos Aires Tramways Company, Ltd. The combination of these two companies working in the same city should be of great advantage, particularly when the City Company's lines have been electrically equipped. Not only should the working expenses and cost of administration be materially reduced, but the receipts very much increased. The capital of the company is to be increased by the sum of £600,000 by the creation of 120,000 new ordinary shares of £5 each.

British Electric Traction Co., Ltd.

THE annual report of this company, which is presented in commendable detail, shows that the results for the past year enable the directors to pay 6 per cent. to the ordinary shareholders, which is a reduction of 2 per cent. from the dividend paid last year. The Chairman attributes this to the large amount of capital at present unproductive, and intimated that the present policy of the directors was to limit as far as possible further capital.

The following comparative tables of three years' working will show the progress of this important company and the financial results.

	1901.	1902.	1903.
Passengers carried	97,671,747	170,340,465	219,714,189
Traffic receipts	£563,360	£922,635	£1,162,005
Share capital (paid up)	£2,000,000	£2,758,615	£2,897,366
Debentures issued (paid up)	£810,906	£1,059,572	£1,491,178
Total	£2,810,906	£3,818,187	£4,388,544
Total of reserve fund	£459,705	£550,042	£580,085
Gross profit	£203,270	£238,961	£290,123

Electric Construction Company, Ltd.

THE report of the Electric Construction Company illustrates the condition of the electrical manufacturing industry as a whole. The report says the year has been marked by excessive competition, and the margin of profit at present prices is small. The dividend is reduced to 4 per cent., which is a reduction of 2 per cent. and is the lowest rate paid since 1897, a steady 6 per cent. distribution having been the usual course. The usual allowance for depreciation and removals of plant has been made. The company's interest in the Crystal Palace District Electric Supply Company has been sold, and the Madras Electric Tramways undertaking has been transferred to the Madras Electric Tramways (1904), Limited, in consideration of £50,000 in cash and £70,000 in fully paid shares.

The Metropolitan Electric Supply Co., Ltd.

THE report of this company states that approximately £700,000 of profit was the result of the sale of the Marylebone portion of the undertaking to the local authority, and the directors propose to give as a bonus £6 per share to the ordinary shareholders, which proposal is being contested by the debenture-holders. The declaration of the profit must be particularly annoying to the Marylebone Council, who now find they are paying £1,415,000 for a portion of an undertaking which the company values at approximately £700,000. While we think it would be impossible successfully to defend the action of the Marylebone authorities in this matter, we regret the announcement of this huge profit out of the ratepayers. The facts will in a very short time become either distorted or forgotten, while the very solid figures will remain, and the feeling will grow that such undertakings should be in the hands of the local authorities from the commencement. It is the experience of similar bargains by other authorities which has advanced the ideas of municipal trading and given some reality to the socialists' dream.

Waterloo and City.

THE half-yearly report of the Waterloo and City Railway shows slightly smaller receipts than the corresponding period of 1903. This is the third consecutive year that this decline has appeared, and the total loss represents 54,000 passengers. The ratio of expenses to revenue has gone up from 46 to 47½ per cent., and after meeting prior charges, there is about £400 less available for Ordinary stock, which with the larger sum carried forward, accounts for the fall of ¼ per cent. per annum in the dividend.

Glasgow Yearly Accounts.

THE Glasgow Electricity Department has recently issued its report of the past year's working, and the results obtained are extremely satisfactory. The gross revenue for the year was £158,190 4*s*. 6*d*., and the working expenditure £61,738 16*s*. 6*d*. The Committee had to meet the following statutory requirements out of the balance; interests on loans £36,023 7*s*. 7*d*. and sinking fund £15,205 10s. 6. at total of £51,228 18*s*., leaving a balance on the year's working of £45,222 9*s*. 11*d*. From this a sum of £2,700 9*s*. 9*d*. was deducted for expenses incurred in the change of consumers' voltage, so that a net balance of £42,522 0*s*. 2*d*. was shown of revenue over expenditure. From the capital account it has been decided to write off £32,180 13*s*. 1*d*. for depreciation at the same rates per cent. as last year. During the year the Committee has repaid the Gas Department the amount at debit of previous year's account £13,895 6*s*. 1*d*., and the surplus on the year's working, £3,553 19*s*., has been carried to the debit of next year's account. The capital expenditure to date is £1,119,047 14*s*.

New ELECTRICAL PATENTS

Selected Specifications.

By E. de PASS, F.Ch. Inst. P.A.,
78 Fleet Street, E.C.

"Breaking and Controlling Electric Circuits."

(No. 14173. Dated June 25, 1903. Frederick William Le Tall, London. Communicated by The Cooper-Hewitt Electric Company of New York.)

This invention relates to an improved method or means for rupturing electric circuits in which currents of high potential or large quantity are carried, and for preventing the flow of an abnormal or dangerous current in a given circuit.

The significant feature of the invention consists in introducing into the circuit to be controlled the resistance of a gas or vapour electric apparatus under such conditions as will, for example, stop the current flow in the circuit without the development of any deleterious sparking and without causing a dangerous rise of potential in any part of the circuit.

Claims.—(1) A circuit-breaking means comprising a metallic circuit shunted by an enclosed gas or vapour path through which path the current is caused to pass when the metallic circuit is interrupted, said gas or vapour shunt-path afterwards offering a prohibitive resistance to the passage of the current.

(2) A circuit-interrupter comprising an enclosed gas or vapour path in parallel with a metallic circuit and having means automatically operated when the current rises above a predetermined value whereby the current is caused to pass through the vapour path instead of through the metallic portion of the circuit.

(3) A circuit-interrupter comprising an enclosed gas or vapour path through which the current passes whereby when the current rises above a predetermined value the circuit is broken owing to the rise of resistance of the vapour due to excessive heating and with or without means for automatically restarting the current through the gas or vapour path when the current falls again below the predetermined value.

(4) A circuit-interrupter for alternating currents comprising an enclosing chamber with a gas or vapour path so arranged that the starting of the current through the vapour path may be accomplished by breaking contact automatically or otherwise between the electrodes within the chamber, the rupture of the circuit occurring when the alternating current approaches a zero-point of the wave.

"Selective Signalling Systems."

(No. 26850. Dated December 8, 1903. Wallace Fairweather. Communicated by the Stromberg Carlson Telephone Manufacturing Co., of Chicago.)

This invention relates to selective signalling systems, and is particularly useful in conjunction with telephone exchange systems in which selective signalling apparatus is employed.

In accordance with the invention, telephone lines are provided, each line leading from a central exchange to a series of sub-stations at each of which selective signalling apparatus is located. Means are provided at the central exchange by means of which any one sub-station may be signalled without effecting the actuation of similar signalling apparatus installed at the other sub-stations. Means are also provided whereby the central operator may cause the connection of telephone apparatus at any one sub-station with the telephone line limbs and whereby the sub-station apparatus at the other sub-stations may be locked out to prevent its use by the subscribers thereat. It is desirable in the operation of such a system that means be provided whereby a central station operator may restore the sub-station selective apparatus to its normal condition when the line is not in use for conversational purposes.

In order that a selective signalling system, such as that disclosed in Specification 26848 of 1903, may be readily installed where switch-boards having old spring jacks with a limited number of contacts are employed, there are provided devices and arrangements in which the restoring signalling device is associated rather with an operator's cord circuit than with the telephone line circuits. If, in the use of a system constructed in accordance with the present inven-

tion, an operator fails to restore a telephone party-line to its normal condition before breaking the connection with her cord-connecting apparatus a positive signal is actuated to notify the operator of her failure to restore the line.

Claims.—(1) In combination, cord-connecting apparatus for connecting telephone lines for conversation, means associated with said cord connecting apparatus for sending current impulses in either direction over a telephone line with which said cord-connecting apparatus is connected, an electromagnetic switching device associated with said cord-connecting apparatus, said switching device being actuated in one direction upon the actuation of said means to send a current impulse in one direction over said line and in the reverse direction upon the actuation of said means to send a current impulse in the reverse direction over said line, and a signalling instrument jointly controlled by said electromagnetic switching device and by the operative position of a plug of said cord-connecting apparatus

(2) In addition to the above, a plug seat switch and a signalling instrument jointly controlled by said electromagnetic switching device and said plug seat switch.

(3) In addition to the above, a signal lamp having a local illuminating circuit jointly controlled by said electromagnetic switching device and said plug seat switch.

(4) In combination, cord-connecting apparatus for connecting telephone lines for conversation, means associated with said cord-connecting apparatus for sending current impulses in either direction over a telephone line with which said cord-connecting apparatus is connected, an electromagnetic switching device associated with said cord-connecting apparatus, said switching device being actuated to close a circuit between switch contacts thereof upon an actuation of said means to send a current impulse in one direction over said line and to open the circuit between said contacts upon the actuation of said means to send a current impulse in the reverse direction over said line, a plug seat switch having contacts adapted to be brought into electrical connection when a plug of said cord-connecting apparatus is seated in its socket, and a signal lamp having a local illuminating circuit including switch contacts of said electromagnetic switching device and of said plug seat switch.

(5) In combination, cord connecting apparatus for connecting telephone lines for conversation, means associated with said cord connecting apparatus for sending a current impulse in either direction over a telephone line with which said cord connecting apparatus is connected, an electrically operated signalling instrument whose controlling circuit includes switch contacts adapted to be brought into electrical connection upon the actuation of said means to send a current impulse in one direction over said line and to be electrically disconnected upon the actuation of said means to send a current impulse in the reverse direction over said line, and additional switch contacts also included in said controlling circuit and controlled by the operative position of a cord plug.

(6) In addition to the above, to send a current impulse in the reverse direction over said line, and a plug seat switch having contacts included in the controlling circuit for said signalling instrument.

(7) In addition to the above, the switch contacts of said plug seat switch being brought into electrical contact when the associated plug of the cord connecting apparatus is seated in its socket and electrically disconnected when said plug is removed from its seat for connection with the telephone line.

(8) In combination, cord connecting apparatus for connecting telephone lines for conversation, a calling key for connecting the terminals of a source of current in one direction with the cord strands, a releasing key for connecting this terminals of said source of current in the reverse direction with the cord strands, a polarised electromagnetic switching device, means whereby the actuation of said calling key causes an actuation of said switching device in one direction, means whereby the actuation of said releasing key causes an actuating of said switching device in the other direction, and electrically actuated signal whose circuit is jointly controlled by said switching device, and switching contacts controlled by the position of a plug of said cord connecting apparatus.

(9) In addition to the above, an electrically operated signal whose controlling circuit includes the contacts, of an electromagnetic switching device, a plug seat whose contacts are included in the controlling circuit for said signal, means whereby the actuation of said calling key causes an actuation of said switching device to close a break in the controlling circuit for said signal, and means whereby the actuation of said releasing key breaks the circuit through said electrically operated signal.

(10) In combination, a telephone party-line leading from a central exchange to a series of sub-stations, selective signalling instruments at each of said sub-stations, cord connecting apparatus at the central exchange for connecting said telephone line for conversation, a calling key for connecting the terminals of a source of current in one direction with the cord strands connected with said telephone line to actuate said selective signalling instrument in connecting the telephone instruments at one of said sub-stations with said telephone line for conversation. a releasing key for connecting the terminals of said source of current in the reverse direction with said cord strands for restoring said selective instruments to their normal condition, an electromagnetic switching device, an electrically operated signal whose controlling circuit includes contacts of said switching device, a plug seat switch having contacts included in said controlling circuit, said contacts being adapted for electrical connection to close said circuit when said plug is seated in its socket, and to be electrically disconnected when said plug is removed from said socket for connection with said telephone line, means whereby the actuation of said calling key causes an actuation of said switching device in one direction to close the break in said controlling circuit between the contacts of said switching device, and means whereby the actuation of the releasing key causes an actuation of said switching device in the reverse direction to break the connection between the contacts of said switching device.

"Apparatus for Automatically Operating the Track and Conductor Switch Points of Electric Tramway Systems."

(No. 7910. Dated April 6, 1903. Joseph Hartley and John Greenwood, both of Leeds.)

This invention relates to apparatus whereby the track and conductor switch points of electric tramway systems may be automatically operated from the car by mechanical means.

It has hitherto been customary to operate the track and conductor switch points by hand; but this method is unsatisfactory in practice, as it necessitates delay, whilst at the same time requiring a pointsman at each crossing in the system.

The object of the invention is to dispense with hand labour; and to this end means are provided on the car and in connection with the track and conductor switch points of such a character that the driver may, whilst standing on the platform of the car, operate the said points automatically, and this in a simple and efficient manner.

Claims.—(1) In apparatus for automatically operating the track and conductor switch points of electric tramway systems, the combination with a mechanically depressed bar located on the car, of a rocking lever located on the track and coupled up to a bell-crank lever connected to the track and conductor switch points, said rocking lever being adapted to actuate the bell-crank lever and move the points on the car coming to the crossing, together with a second bell-crank lever located on the track and coupled up to the first mentioned bell-crank lever adapted to return the points to their normal positions on the car-wheels passing over a push-rod in connection with the said second bell-crank lever arrangement.

(2) The combination and arrangement of parts constituting the apparatus for automatically operating the track and conductor switch points of electric tramway systems.

"Compounding of Synchronous Alternators for Single and Polyphase Electric Currents."

(No. 8831. Dated April 18, 1903. Alexander Heyland, of Brussels.)

This invention relates to alternators carrying fixed poles in a given direction on the inducing part (rotor or stator) like an ordinary alternate-current machine provided with direct-current excitation on the field magnets. In these synchronous machines it is necessary, in order to compound them for constant potential and for any phase difference to increase the excitation of the poles by a current of constant direction, which is proportional to the wattless component, *i.e.*, to the sine of phase difference of the current supplied to the machine.

According to this invention, the supply of the sine component of the current is effected by a commutator to which the main current, or a current proportional thereto, such as one derived from a transformer in the circuit of the machine, is supplied. The various segments of this commutator are connected to each other by various circuits differing by a quarter of a period, some of the circuits (the pole winding) taking a given component of the current (the wattless current), while the other circuits take up current of a different phase.

Claims.—(1) A compounding of synchronous machines, which compounding consists in simultaneously redressing and decomposing by means of a commutator the main current, or a current proportional to the main current, into its two components, the watt current and the wattless current, by so connecting the pole winding to the said commutator that two groups of circuits differing between themselves by a quarter of a period are formed, and that, in consequence of the position of the brushes, the wattless component traverses the pole winding in a given constant direction, while the watt component is led away through the circuits that differ by a quarter of a period relatively to the pole winding, or traverses various parts of the pole winding in opposite directions, so that it exerts no magnetising effect on the winding.

(2) A constructional form of the arrangement described in Claim 1, in which constructional form the poles carry two separate windings, to one of which direct current or commutator alternate current is supplied for the excitation of the field, while the other winding (the compounding winding) serves to compound the field in the described manner.

(3) A constructional form of the arrangement specified in Claim 1, which constructional form consists in using the pole winding connected to the commutator simultaneously as excitation winding, by supplying simultaneously to it, in addition to the compounding current, a current of constant direction to excite the field.

(4) A constructional form of the arrangement specified in Claim 1, in which constructional form the machine is provided with circuit connections in accordance with the compounding arrangements described in the Specification of British Letters Patent No. 25,221 of December 10, 1901, for the purpose of producing, in addition to the compounding, a simultaneous auto-excitation of the machine.

(5) A constructional form of the arrangement specified in Claim 1, in which constructional form the arrangements claimed in the claiming clauses (1), (2), (3) and (4) are applied to the poles of the direct-current exciting machine, instead of to the poles of the alternate-current machines themselves.

A First Book of Electricity and Magnetism.

By W. PERREN MAYCOCK. London: Whittaker & Co., Paternoster Square, E.C. Price 2*s*. 6*d*.

This useful little volume, now in its third edition, has been entirely revised, and in this form possesses many additional features which should render it still more valuable to beginners in the electrical field. It has three principal parts, dealing with magnetism, electrokinetics, and electrostatics. In addition, there is a list of experiments at the end which will be an aid to teacher and student, while a price-list of the apparatus needed or mentioned in the book should be of considerable value to both.

Starters and Regulators for Electric Motors and Generators.

RUDOLPH KRAUSE. Translated by C. Kinzbrunner and N. West. London: Harper Brothers, Albemarle Street, W. 1904. Price 4*s*. 6*d*.

The style, arrangement, and illustration of this work leave little to be desired. The subject treated is one of considerable importance, and so far as we know no other separate work treating of it has yet appeared in English. In the present case the theory and practice of motor-starters and generator-regulators is concisely treated, and to those engaged in the design of such apparatus it should be of some use. As a rule, workers in this field have their own little code of rules and nothing will alter their opinion of them, but there are others needing preliminary guidance, and to such the present volume can be recommended. The diagrams chiefly deal with connections of starters and regulators, and the mechanical parts of the same. We do not notice any reference to an important branch of the subject—the actual *winding* of coils. So many forms are employed that an additional chapter on them would have enhanced the value of the work.

The Electrical Industry.

By A. G. WHYTE, B.Sc. London: Methuen & Co., Essex Street, W.C. Price 2*s*. 6*d*.

How often the work of treating some electrical subject in a popular manner falls into the hands of persons ill suited to deal with them is too well known. The present volume forms part of a popular series, "Books on Business," and under less favourable circumstances would have shared the fate of several similar works. We are happy to say, however, that this has not been the case, and we heartily welcome Mr. Whyte's little book as a well-voiced, concise statement of our case—the case for the electrical industry, and why and where it ranks among other industries. Those of our readers who want a history of the industry we are privileged to represent should lose no time in obtaining a copy of this work, and in its perusal we are confident they will not be disappointed. Many among us are profoundly ignorant of the birth and infancy—that much-belated infancy—of the electrical industry, while many more have been wanting some historical account which would be interesting, readable, and free from technicalities. In the book before us all this and more is condensed, and we turn from its pages convinced that by it a space long vacant has now been filled.

Electrical Engineering.

By W. SLINGO and A. BROOKER. London: Longmans Green & Co., 39 Paternoster Row, E.C. Price 12*s*.

The difficulty of revising a work written many years ago with a view to modernising it, without rewriting, is fully exemplified in the present volume. Who among the older men of the profession has not loving recollections of "Slingo and Brooker"? and who would yet see it used as much as before? In the technical schools, no doubt, this work is widely perused, and deservedly so; but we would recommend the authors, when next undertaking a revision, to include illustrations of modern machines and apparatus. Students can derive benefit from the concise yet simple statements of the fundaments of electrical engineering, as set forth in the pages of this volume, but with even greater benefit when examples from modern practice are used as typical illustrations. We advise students to read the note to the present edition, which explains the object of the work and the field it is intended to cover. On this basis, we can only commend it, and heartily, to our student-readers as a work fitted to start them on their course of training for the wider branches of electrical engineering to be found beyond the technical colleges.

Modern Engines and Power Generators.

By RANKIN KENNEDY. Vols. ii. and iii. London: The Caxton Publishing Co., Chancery Lane, E.C. Price 9*s*.

Volume ii. of this comprehensive work deals with the heat engine, or that form of prime mover employing a true gas or air directly in its cylinders. The Deisel engine comes in for exhaustive treatment, and as this type of engine is again coming to the

front the data given should be read with interest. There are three interesting chapters in the work, which covers the entire known field of gas- and oil-engines in a very concise manner. Considerable space is devoted to marine motors, and also to the design of large marine gas-engines. The section on gas-generators contains data which should be valuable for reference. Seeing that so much attention is now being paid to the serious development and exploitation of internal-combustion engines, the volume appears at an opportune moment, and we reiterate our recommendation of it to central-station engineers. In the third volume a special subject is made of the chief prime movers employed on road vehicles. Steam and petrol vehicles claim the greatest attention, but twelve pages being set apart for electric cars. Still, we are familiar with the chief points of the latter vehicle, and there is little new to be said about it. The first volume was reviewed in No. 4 (vol. i. p. 443).

Modern Electric Practice.

Editor: PROF. MAGNUS MCLEAN, M.A., D.Sc. Vol. iii. London: The Gresham Publishing Co. Price 9s.

We have already commented favourably on the first two volumes of this work, and in dealing with the third we must add further praise to our previous remarks on the arrangement of the work as it now develops. In this volume the subjects treated, each the speciality of a recognised expert, are distribution and transmission of energy, electric light wiring, electric fittings, arc lamps, and incandescent lamps. This completes the second section, which commenced in vol. ii. with switches and switch gear. The third section is also started in the present volume, and deals with electric tramways, containing in this case two chapters on the rails and rail bonding.

The chapter on distribution and transmission of electric energy is subdivided into five chapters, dealing with the aim of electrical distribution, systems of transmission and distribution, power equipment, transmission lines, and the cost of electric energy. The generation transmission and distribution of energy are treated from the basis of standard polyphase practice. The concluding chapter dealing with costs, is very instructive, and classifies the various costs in a very handy form. Under electric light wiring the various systems of interior wiring are described, and the section on electric fittings is complete as a record of what is now done in that branch of electric lighting. Under arc lamps there is much useful data included among which we must refer specially to that on the theory of the lamps. The most typical examples of lamps are selected and described, and the section concludes with notes on the installation of lamps.

The section on incandescent lamps is as complete as could well be wished for, the manufacture of the lamps being described in the minutest detail. At the time the chapter was written little will have been published on the subject of non carbon lamps, so that the chapter dealing with them is particularly scanty, not even an illustration of the Nernst lamp being given.

Under electric tramways, the first chapter on rails is of necessity somewhat short, but it covers the ground very well, though we should have liked to see some reference to electric rail welding. The chapter on rail bonding is also comparatively short, but here again the subject is concisely treated. This chapter brings to a close the third volume, which can be placed with equal confidence beside its predecessors. We can recommend this work to engineers requiring a compendium of information in a classified on all branches of electrical engineering.

The World's ELECTRICAL LITERATURE

The leading contents of the periodical electrical press of the world, papers read before Learned Societies, and any other literature treating upon electrical subjects are arranged *under subject-matter* in this section. Suitable references are made to the names and dates of the various papers, and the whole forms an index guide of considerable importance and value.

Power.

Articles.

Electric Plant at the Ruti Weaving Mill.	*Electro. June/04.*
Electric Sterilisation of Milk. E. Guarini.	*Sci. Amer. July/04.*
*Steam *v.* Electrically Driven Winding Gears. F. Hurd.	*Elec. Power, July/04.*
Moulineaux Power Station, Paris. F. Paul.	*Amer. Elec. July/04.*
*Cost of Water and Electric Power. G. E. Walsh.	*Amer. Elec. July/04.*
Variable Speed Motors. The Bullock Systems. W. Baxter (jnr.).	*Machinery N.Y. July/04.*
Missouri River Power Station of Metropolitan Strt. Rly. Co. H. P. Quick.	*Strt. Rly. Rev. July/04.*
*Kingsbridge Power Station of N.Y. City Railway Company.	*Strt. Rly. Jrnl. 2/7/04.*
Large Switchboard at St. Louis Exposition.	*Elec. Wrld. & Engr. 2/7/04.*
A Peruvian High-Voltage Transmission Plant. A. L. Kenyon.	*Elec. Wrld. & Engr. 2/7/04.*
Electric *v.* Hydraulic Cranes. F. B. Kleinhaus.	*Elec. Wrld. & Engr. 2/7/04.*
The Location of Lightning Arresters. J. W.	*Elec. Rev. 5/8/04.*
Recent Applications of Electricity on a Small Scale. H. S. Knowlton.	*Electy. N.Y. 6/7/04.*
Electric Cranes. II. F. L. Berry.	*Mech. World. 8/7/04.*
On the Use of Gas-motors in the Production of Electricity.	*Munch. Ecl. Elec. 9/7/04.*
Turbo-dynamos. F. L.	*L'Ind. Elec. 10/7/04.*
Steam Turbines. Drin.	*La Rev. Elec. 15/7/04.*
Electrical Equipment of Overhead Travelling Cranes. J. W. Warr.	*Elec. Rev. 15/7/04.*
Electricity at the Washington Navy Yard. J. E. Price.	*Elec. Rev. N.Y. 16/7/04.*
Large Westinghouse-Parsons Turbines. Revyal.	*L'Ecl. Elec. 16/7/04.*
*Some Tests of Iron and Wood Working Machinery. C. H. Hines.	*Elec. Wrld. & Engr. 16/7/04.*
Hydro-Electric Plant at the Snoqualmie Falls.	*L'Electn. 16 7 04.*
Hydro-Electric Power Development on the Catawba Riv.	*Elec. Wrld. & Engr. 23/7/04.*
Electrical Engineering in South Africa. J. Roberts.	*Electn. 29/7/04.*
New Waterside Power House of the Edison Electrical Company at New York. Domar.	*L'Electn. 30/7/04.*
*Voltage Potential and Direction of Transmission.	*Elec. Wrld. & Engr. 30/7/04.*
Power Generation and Distribution at a Large Railroad Workshop.	*Elec. Wrld. & Engr. 30/7/04.*
*Electrical Machinery for Panama. G. E. Walsh.	*Elec. Rev. N.Y. 30/7/04.*
New Switching Station at Colorado City.	*Elec. Rev. 30/7/04.*

Papers before Societies.

Notes on the Regulation of Generating Sets. Neyret.	*Sté. des Ing. Civ. de France, May/04.*

Traction and Transport.

Articles.

Three-Phase System from Schwyz to Seewern. E. Guarini.	*Strt. Rly. Rev. July/04.*
*Inspection and Care of Car-Wheels. R. B. Stearns.	*Strt. Rly. Rev July/04.*
Four-Wheel Drive Electric Freight Truck. C. Ridderhof.	*Machinery N.Y. July/04.*
*The Vesuvius Electric Railway. F. Koester.	*Elec. Rev. N.Y. 2/7/04.*
*" The Accounting Dept. is Not a Revenue Producing Dept." W. B. Brockway.	*Strt. Rly. Jrnl. 2/7/04.*
The Electrical Development of Eastern Railroads. G. E. Walsh.	*Westn. Elec. 2/7/04.*
The Electrical Engineer and the Steam Road. H. S. Knowlton.	*Elec. Rev. 3/8/04.*
Monophase Motor with Great Starting Torque. F. L.	*L'Ind. Elec. 10/7/04.*
Electric Haulage on Railways. D. S. Munro.	*Pract. Engr. 15/7/04.*
Electric Installation of the Cornwall Canal (Canada). Dary.	*L'Electn. 23/7/04.*
Electric Locomotives of the New York Central. A. B.	*L'Electn. 16/7/04.*
Tramways and Compulsory Running Powers. T. Upton.	*Elec. Rev. 29/7/04. 29/7/04.*
Inverted Third Rail on Brooklyn Bridge	*Strt. Rly. Jrnl. 30/7/04.*
Analysis of Traffic and Methods of Development. H. W. Brooks (jnr.).	*Strt. Rly. Jrnl. 30/7/04.*

Lighting and Heating.

Articles.

*The Illumination of the Main Picture of the St. Louis Exposition.	*Westn. Elec. 25/6/04.*
Wiring for Mills and Factories. A. B. Weeks.	*Amer. Elec. July/04.*
Wiring Leaflets. (Contd.) N. Harrison.	*Electy. N.Y. 6/7/04.*
Lighting and Heating Plant, Bloomington and Normal.	*Westn. Elec. 9/7/04.*
Tarification of Electrical Energy. Goubaux.	*L'Ind. Elec. 10/7/04.*
Weissmann Electric Pearls. Pausert.	*La Rev. Elec. 15/7/04.*
Actual Results Obtained During the Use of Various Electric Wiring Systems. F. H. M.	*Elec. Engr. 15/7/04.*
Wiring Leaflets. N. Harrison.	*Elec. N.Y. 20/7/04.*
The Measurements of Induction Co-efficients and of Energy-Loss in Alternate-Current Apparatus. Dolezalet.	*L'Electn. 23/7/04.*
On the Measurement of the Luminous Flux of Incandescence Lamps. Léonard.	*L'Ecl. Elec. 23/7/04.*
Study of the Propagation of Current During the Variable Period on a Line Provided with a Receiver. Poincaré.	*L'Ecl. Elec. 23/7/04, 30/7/04.*
New Multiple Tariff Meter. F. L.	*L'Ind. Elec. 25/7/04.*
The " Bonhivers " Diffuser. de Kermond.	*L'Electn. 30/7/04.*
Electrostatic Illuminations. H. B. Dailey	*Sci. Amer. 30/7/04.*

Telegraphy and Telephony.

Articles.

Direct-Call Telephonic Apparatus. Dardeau system.	*L'Electn. June/04.*
Poulsen Telegraphone.	*Electro. June/04.*
Improving Telephone Service in Private Branch Exchanges. H. S. Knowlton.	*Westn. Elec.* 25/6/04.
Telephone Traffic Dept. Methods. C. H. Coar.	*Amer. Elec.* July/04.
Electric Fakes and Fakirs. G. W. Wilder.	*Sound Waves,* July/04.
A Typical Private Branch System. J. C. Kelsey.	*Sound Waves,* July/04.
Divided Multiple. S. A. Beyland.	*Sound Waves,* July/04.
Electrolysis on Underground Cables. A. E. Dobbs.	*Sound Waves,* July/04.
Telephone Conditions in the Orient.	*Amer. Telep. Jrnl.* 2/7/04.
*Methods of Handling Toll Business. T. S. Lane.	*Amer. Telep. Jrnl.* 2/7/04.
Oil Film Receiver for Space Telegraphy.	*Westn. Elec.* 9/7/04.
*Long-Distance Toll Accounting. I. C. L. Norton.	*Amer. Telep. Jrnl.* 16/7/04, 23/7/04.
Telephone Maps. W. H. Elgin.	*Amer. Telep. Jrnl.* 16/7/04.
*Telephone Lead-Covered Cables Attacked by an Insect.	*Elec. Wrld. & Engr.* 16/7/04.
*Rochefort System of Wireless Telegraphy. A. F. Collins.	*Elec. Wrld. & Engr.* 16/7/04.
*New Telephone Exchange, Buda Pesth. T. Hollos.	*Elec. Wrld. & Engr.* 16/7/04.
Remarks on Instrument Setting Protective Devices. B. C. Wilhelm.	*Amer. Telep. Jrnl.* 23/7/04.
Storage Battery Records in Telephone Practice. H. S. Knowlton.	*Elec. Wrld. & Engr.* 23/7/04.
Portable Space Telegraph Stations for Military Purposes.	*Westn. Elec.* 23/7/04.
Preaching by Telephone.	*Amer. Telep. Jrnl.* 30/7/04.
Construction and Operation of Exchange Circuits. I. E. F. Parker.	*Amer. Telep. Jrnl.* 30/7/04.
Evolution of Telephonic Protective Apparatus. C. H. Coar.	*Elec. Wrld. & Engr.* 30/7/04.
Synthetic Wireless Telegraphy. A. F. Collins.	*Elec. Wrld. & Engr.* 30/7/04.
Cost and Compensation. C. H. Judson.	*Amer. Telep. Jrnl.* 30/7/04
*Use of the Peg Count in Central Office Operation. III. A. D. O'Brien.	*Amer. Telep. Jrnl.* 30/7/04.
Telephone Engineering. VIII. J. C. Kelsey.	*Amer. Telep. Jrnl.* 30/7/04.

Papers.

On the Setting of Watches at Sea by Wireless Telegraphy. Normand.	*Acad. des Scs. Paris,* 11/7/04.

Electro-Chemistry.

Articles.

Electrolytic Galvanisation. Becker.	*L'Ind. Elec.-Chem. June/04.*
New System for the Charging of Accumulators. Alois Micka.	*La Energ. Electri.*
Contribution to Theory of Jungner-Edison Accumulator with Constant Electrolyte. M. U. Schoop.	*Elec.-Chem. Ind. July/04.*
Adaptability of Artificial Graphite Articles. C. L. Collins.	*Elec.-Chem. Ind. July/04.*
Electro-Chemical Laboratory of the Massachusetts School of Technology. H. M. Goodwin.	*Elec.-Chem. Ind. July/04.*
Influence of Electricity on Vegetation.	*Westn. Elec.* 9/7/04.
The Formation of Terrestrial Rocks Explained by Electro-Chemistry.	*L'Electrol.* 1/8/04.

Papers.

Influence of Current Density in Electrolysis by Alternate Current. Brochet et Petit.	*Acad. des Scs. Paris* 18/7/04.

Electro-Physics.

Articles.

Theoretical Study of Monophase Commutator Motors. (Serial.) Lehmann.	*L'Ecl. Elec.* 9/7/04. (Concld.) 16/7/04
Application of Radium Salts to Study of Atmospheric Electricity. Th. Moureaux.	*Westn. Elec.* 16/7/04.
*The Inverted Repulsion Motor. K. Faber.	*Elec. Wrld. & Engr.* 16/7/04.
*On the Complex Product of Electromotive Force, Current, and other Vectors. H. T. Eddy.	*Elec. Wrld. & Engr.* 23/7/04.
Notes on X-Light. W. Rollins.	*Elec. Rev.* 30/7/04.
New Models of Blondel Oscillographs. Solier.	*L'Elec.* 30/7/04.

Papers.

The Age of Science. S. A. Remsen.	*Worces. Polytech.* 9/6/04.
On Cathodic Rays. Villard.	*Acad. des Scs. Paris* 4/7/04.
On Cathodic Rays and Magnetofriction. Pellat.	*Acad. des Scs. Paris.* 11/7/04.
On a New Method of Observing N-Rays Blondlot.	*Acad. des Scs. Paris* 11/7/04.
On the Nature of N and N^1-Rays and the Radio-Activity of the Bodies Emitting them. Becquerel.	*Acad. des Scs. Paris*
On the Refraction of N and N^1-Rays. Becquerel.	*Acad. des Scs. Paris* 25/7/04.

Electro-Metallurgy.

Articles.

Electro-Metallurgy of Bismuth. Becker.	*L'Ind. Elec.-Chem. June/04.*
The Electrolytic Process of Refining Gold Alloys. E. Wohlwill.	*Electro.-Chem. Ind. July/04.*
Actual State of the Electro-Metallurgical Industries. (Serial.) Izart.	*L'Ind. Elec.* 10/7/04, 25/7/04.

Students.

Articles.

Winding a Direct-Current Generator Armature. A. Wagner.	*Elec. Club Jrnl. July/04.*
The Circular Mill, its Derivation and Calculation. C. Traverst.	*Amer. Telep. Jrnl.* 23/7/04.

Manufacturers.

Articles.

Invention and Success. E. V. Winkle.	*Elec. Wrld. & Engr.* 2/7/04.
*Iron Losses in Loaded Transformers. Dr. E. S. Johonot.	*Elec. Wrld. & Engr.* 2/7/04.
The Works of the G. E. Co. Schenectady.	*Engng.* 5/8/04.
Zone Dynamos and Motors. H. F. Joel.	*Elec. Rev.* 5/8/04.
*Self-Excited and Compounded Alternators.	*Electn.* 15/7/04.
Methods of Loading Machines for Testing Purposes Supplying on the Losses. (II.) E. A. Regenstein.	*Elec. Rev. N.Y.* 23/7/04.

Central Station Practice.

Articles.

Smokeless Boiler Setting. A. Bement.	*Amer. Elec. July/04.*
Central Electrical Stations. T. Champness.	*Public Works, July/04.*
Some Critical Observations in a Central Station. H. S. Knowlton.	*Elec. Rev. N.Y.* 16/7/04.
Artificial Loads for the Dissipation of Electric Power. F. H. Davies.	*Elec.Eng.* 22/7/04.
A Simple Method for Calibrating Integrating Meters. D. P. Morrison.	*Elec. World. & Eng.* 23/7/04.
Tendencies in Sub-station Design. H. S. Knowlton.	*Westn. Elec.* 23/7/04.

Articles marked with an asterisk are of exceptional interest, and well worth reading. Copies of any article or paper can be obtained on application to this office, a nominal fee only being charged for the clerical time occupied in taking out same. If desired, the whole publication will be procured (same not being out of print) on payment of the published price.

Where foreign papers have a similar title to those published in this country, the initial letters of the place of publication will be inserted after the abbreviated name of the particular paper; for instance, the English Electrical Review will be abbreviated Elec. Rev., and the American Electrical Review, Elec. Rev. N.Y.

New Catalogues.

Power.

Motor Controllers.

WITTING EBORALL & CO., LTD., Temple Bar House, E.C. Leaflets Nos. 105 and 105A give particulars and prices respectively of standard controllers for direct-current and three-phase motors. These are of the drum type, similar to a tramcar controller. They are very compact and are fitted with spark-arresters to keep down arcing at the contacts and fingers. The leaflets also give illustrated particulars of standard resistances for these controllers. The alternating-current controllers are made in two types, Pd, and Pf, and the direct-current controllers in three types, Pa, Pb, and Pc.

Lighting and Heating.

Arc Lamps and Fans.

THE ELECTRICAL COMPANY, LTD., Charing Cross Road, W.C. Two booklets have recently been sent out by this firm dealing with their "Luna" flame arc lamps and desk and wall fans. Particulars and prices are given in each case.

Switch and Cut-out Boards.

THE GENERAL ELECTRIC COMPANY, LTD., 71 Queen Victoria Street, E.C. The "*General*" *Electric Progress Sheet* for July (No. 52) contains particulars and prices of switch and cut-out boards, branch cut-outs, pendants and novel adjustable brackets. Protected wall plugs and a few linesman's accessories are also included.

Fans.

THE GENERAL ELECTRIC COMPANY, LTD. (as above). The "Fan Section" of this company's catalogue is before us, and during the hot weather one is perceptibly cooler by reading it. "Freezor" fans for alternating-current and direct-current circuits are described, and priced, together with many other cooling novelties in the way of ceiling fans, bracket fans, and oscillating fittings for directing the "breeze."

Electrical Accessories.

MARSH, SON & CO., LTD., 15 Gerrard Street, Soho, W. We have been supplied with a weighty volume in the shape of this company's catalogue of electrical accessories, and it does full justice to the subject and the company. The chief specialities are wiring accessories, telephones, and telephone equipments, instruments, arc lamps wiring conduits, ignition accessories, dynamos and motors, fittings, shades, electroliers, &c. A comprehensive index completes the publication, which is very handsomely printed and bound in red cloth.

Telegraphy and Telephony.

Telephones.

THE GENERAL ELECTRIC COMPANY, LTD., 71 Queen Victoria Street, E.C. The "S.S." or Secret Service telephone system of this firm is described in pamphlet (K) 1066. The system has been worked out in considerable detail and possesses the advantage of complete secrecy. In addition to permitting the interchange of conversation in the usual way, indicators are fitted which show the number calling when the office may happen to be empty. A complete record of calls is thus made. The system is developed for wall and table instruments. No exchange is needed up to twenty-four lines, this being the maximum number stated in the list. The telephones can, however, be used in the capacity of a central station instrument for intercommunication between outlying stations.

Central Station Practice.

Steam Dryers.

HOLDEN AND BROOKE, LTD., Sirius Works, West Gorton, Manchester. List No. 64 gives full details of Brookes' Patent water-separators or steam-dryers. These are described and illustrated in our Manufacturers' Section this month (p. 184). The list is very comprehensive and gives in addition prices of dryers and particulars of flanges for varying steam-pipes. The list closes with a number of testimonials. Lists Nos. 66 and 67 deal respectively with Brookes' motor-waggon injector and protected seat valve.

Measuring Instruments.

THE ELECTRICAL COMPANY, Charing Cross Road, W.C. Two booklets dealing with the company's measuring instruments have reached us. One of these deals with testing and standardising instruments for alternating-current and direct-current circuits. Full prices and details are given. The second booklet is given up to switchboard instruments, and includes a line of induction instruments for alternating-current circuits which are of considerable interest. The growth of the remote control board is largely responsible for the introduction of low-tension instruments operated from high-tension transformers.

Cables.

W. T. GLOVER & CO., LTD., Trafford Park, Manchester. The handsome catalogue of electrical wires and cables recently issued by this well-known company is valuable in more senses than one. In addition to performing the ordinary functions of a catalogue, it remains in constant service as a work of reference on almost all matters relating to cables and wires. Its value is enhanced by a convenient thumb index, a glance at which puts you "there" with a minimum of trouble. The firm's specialities include fire-resisting cables, leather-sheathed cables, suspension strands, "Diatrine" leadless cables, and Diatrine cables in single, twin, concentric, triple concentric, and three-core varieties I.E.E. wiring tables and useful formulæ conclude a most interesting compilation.

Metallic Packing.

THE UNITED STATES METALLIC PACKING COMPANY, Soho Works, Bradford. We have just received a neat twenty-one-year calendar from this firm in the shape of an aluminium medallion, one side of which is stamped with a neat section of a stuffing-box, and surrounding this the company's name, &c., the other side forming the calendar proper. This is composed of two scales, one on the reverse of the medallion, the other on the upper face of a circular disc, notched in suitable places to expose the years and the days of the week. A very simple adjustment is needed and the disc will remain where set for continued reference. The medallion is about the size of a four-shilling piece and can be easily carried in the vest-pocket. We understand that the company will forward one to any engineer interested in United States metallic packing.

Switchboard Instruments, &c.

FERRANTI LIMITED, Hollinwood, Lancs. A series comprising six leaflets punched ready for filing has been forwarded by the above firm. They deal respectively, starting from No. 1, with reverse current relay for continuous currents (*see* No. 6, vol. i. p. 641), moving coil instruments round type, ammeter shunts, current transformers, alternating current switchboard wattmeters, potential transformers. The round type instruments are on the D'Arsonval principle, with permanent magnet moving coil actions. The current transformers are neatly assembled in current instrument cases and built for circuits, from 500 to 10,000 volts, with suitable terminals in each case. For voltages above 5,000 the cases are oil-filled. The switchboard alternating current wattmeter is a similar instrument to that described in our first issue, page 77, but is enclosed in an aluminium alloy case with glass sides.

The potential transformers are made in two classes, with and without cases. The former suited for primary voltages between 500 and 5,000, and the latter between 500 and 30,000, volts. The secondaries are designed for a standard pressure of 100 volts. The ratios are carefully checked and can be relied upon, and the transformers are warranted cool even when used with synchronisers.

SHORT NOTICE.

Students' Gathering.

THE Northampton Institute Day Students held their annual dinner on Friday, July 8, at Anderton's Hotel, Fleet Street, E.C. There was an unusually large gathering, and a very successful evening ensued. Among the guests were present Dr. R. Mullineux Walmsley, Dr. C. V. Drysdale, Messrs. C. E. Larard, S. Field, and W. E. Curnock.

Forthcoming Events

Exhibitions.

Universal Exposition, St. Louis, U.S.A.
Now open. Remains open till *December* 1, 1904.

Exposition Internationale au Grand Palais, Paris.
August to November 1904.

Industrial Exhibition, Cape Town.
November 1904 *to January* 1905.

Institution of Electrical Engineers' Visit to America.
THE date for this visit has been fixed to permit members to attend the International Electrical Congress, to be held in September, at the St. Louis Exhibition (*see* note below). The party will leave England on or about August 26 or 27, 1904, and five to six weeks is about the time which will elapse between leaving and returning to England.

Papers before Societies.

St. Louis International Association of Municipal Electricians.
September 13 *and* 14, 1904.
"Street Lighting: Principles Involved and Systems Used." A. S. Hatch.
"The Limitations of the Telephone for Fire Alarm Purposes." A. Bosch.
"The Inspection of Theatres from an Electrical Standpoint." W. H. Thompson.
"Methods of Testing." W. M. Petty.

Meetings, Conventions, etc.

American Street Railway Association.
23rd Annual Convention. St. Louis Exposition. *October* 12 *and* 13, 1904.

International Electrical Congress, St. Louis Exposition.
Conventions will be held by the following Societies: the American Institute of Electrical Engineers, the American Physical Society, the American Electro-Chemical Society, the American Electrotherapeutic Association, the International Association of Municipal Electricians, the British Institution of Electrical Engineers. Delegates from the Société Internationale des Electriciens, the National Electric Light Association, and the Association of Edison Illuminating Companies.

The following papers have been promised for section A, the section on theory, of which Professor E. L. Nichols is chairman, and Professor H. T. Barnes is secretary.

"*Foreign*: "Metallic Conduction," Professor Dr. Paul Drude; Electrical Standards," Professor Dr. W. Jaeger; "Ions," Sir Oliver Lodge; "Magneto-Striction," Professor H. Nagaoka; "The Theory of Ionisation by Collision," Professor J. S. Townsend; "Secondary Standards of Lights," M. J. Violle; "Condensation Nuclei," Mr. C. T. R. Wilson; "Magneto-Optics," Professor P. Zeemann. *American*: "The Mechanical Equivalent of Heat as Measured by Electrical Means," Professor H. T. Barnes; "Atmospheric Nuclei," Dr. Carl Barus; "The State of Our Knowledge Regarding the Earth's Magnetism," Dr. Louis A. Bauer; "Magneto-Optics," Professor D. B. Brace; "The Absolute Value of the Electromotive Force of the Clark and Weston Cells," Professor H. S. Carhart and G. W. Patterson, jun.; "The Electric Arc," Professor C. D. Child; "Coherer Action," Dr. K. E. Guthe; "Electrical Discharges in Gases," Professor E. P. Lewis; "Electro-Striction," Professor L. T. More; "The Unobtained Wave-Lengths between the Longest Thermal and the Shortest Electric Waves yet Measured," Professor E. Fox Nichols; "Standards of Light," Professor E. L. Nichols; "Magnetic Effect of Moving Charges," Harold Pender; "Electrical Theory," Dr. M. I. Pupin; "Alternating-Current Measurements," Dr. Edward B. Rosa; "Radioactive Change" Professor E. Rutherford; "Radioactivity of the Atmosphere," Professor J. C. McLennan; "Electrical Discharge in Gases," Professor J. Trowbridge; "Electrical Theory," Professor A. G. Webster.

Miscellaneous.

Three Phase v. Continuous Current.

BEFORE the recent meeting of the Institute of Mining Engineers, to which we have referred, a paper on the above subject was read and discussed. The author has had ample opportunity of trying every apparatus as it came out, his colliery being owned by a nobleman, who gave him *carte blanche*. After trying every apparatus, he finally decided that Turbo-Generators, delivering three-phase currents, were the best for his work, and he has been able to adapt them to every kind of work about the colliery, including driving coal-cutting machines. His principal reason for this view was the greater simplicity of three-phase apparatus, and the absence of commutators. In the discussion which took place, it was pointed out by makers of continuous current apparatus that, as three-phase motors had to run with very small clearance indeed between the rotor and the stator, stoppages might occur from very slight causes. Three such cases were mentioned, one by the maker of continuous current apparatus, and the others by a contractor and the author of the paper. In one case a film of coal-dust had been sufficient to stop a three-phase motor; in another, a slight wear on a bearing had allowed the rotor to move out of its proper centre; and in the third, contact had actually taken place between the rotor and stator. The trouble in some of these cases was to find the cause of the stoppage. Where the bearing was worn the rotor was apparently in order, and it was only after considerable time had been spent and everything had been tested that the real cause was discovered.

Wireless Advertising.

RECENT events seem to show that in wireless telegraphy the stage of advertising has arrived. First appears a letter in the *Electrician* by Prof. F. Braun, laying claim to the invention of the closed oscillating-circuit system; next a letter from Dr. de Forest, pointing out that neither Braun nor Marconi, nor yet Stone, is the real inventor (who is held to be Prof. Fessenden—at least by de Forest). Next, one comes across a letter from the de Forest operator in the Far East, who says that no one practically can catch their messages. This is repeated in a *Daily Mail* interview with Mr. Maguire, the Vice-President of the de Forest Co.; and finally, a pamphlet issued broadcast by the Gesellschaft für Drahtlose Telegraphie, under the signature of Count Arco, disposes of this claim in a somewhat drastic manner. Dealing first with the de Forest system, it is pointed out that the claim that the oscillations are perceptible only to de Forest apparatus is akin to the claim once put in, that in a certain electrical plant only those lamps made by the firm itself would burn; other makes could not be utilised. This is, of course, pushing the matter too far. The Marconi syntonic system is next exposed (as the author thinks), and at last one comes to what the German system *will* accomplish. This need not be detailed, although a fresh advertisement might be much desired, but it suffices to say that the pamphlet is at least entertaining reading.

The

Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

Associate Editors: Leading Authorities in every branch of Electrical Activity.

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MILITARISM AND ELECTRIC PROGRESS.

THE arguments advanced by "A Lover of Justice" in the *Westminster Review* (August) under the title "Europe's Military Madness and the Way out of it," in support of a proposal for the disarmament of Great Britain, are of sufficient importance to merit their comparison with the possible progress and ultimate status of the electrical industry in this country. Before drawing this mental picture we would commend the *dictum* to the notice of our readers, not in the spirit of acquiescence to the writer's opinions, but rather with the idea of drawing attention to the complete development of his subject, as for our purpose we can only enter upon certain of its phases. To correctly gauge the possible influences of militarism on the progress of electrical affairs, more particularly in this country, we must first consider the effects which that industry is having on our commercial and national welfare. For the development of our industry to the present day we can say little more than that the results achieved are a lasting monument to enterprise and energy, especially that displayed by the pioneer workers. Through varying phases, though the tendency has always been upward, electrical science has permeated every phase of life, and although at present the benefits it conveys are chiefly noticeable in commercial spheres, there are strong indications of its effecting revolutionary influences in social circles before many years are over. In a word, the relations between electricity, as now generated and distributed, and the State will be of so vital a character that it will take precedence over all the other adaptations of natural means to social ends which man has called to his aid. Its importance as a commercial asset will be fully realised, and measures taken to extend the advantages it conveys to every sphere of industrial activity. Already there are signs of the wider employment of electric power and its bearing on the better conduct of manufacture is becoming recognised. If the same ascendant and absorbent character continues to be the chief feature of electric progress the tendency to obstruction at one time and even now evident, will meet with no encouragement. The confidence of the community in the power of electricity for social amelioration, commercial resuscitation and even national defence will thus be gradually engendered and the reliance at one time placed upon older methods will be transferred to newer modes, which by experience have proved their efficacy beyond doubt. This acceptance of new ideas, adaptation to changed environment, placing national welfare under the wing of invention, call it what we may, will naturally entail the abandonment of all else which has led us to our present position. Like the

climber "Scorning the base degrees by which he did ascend," we shall cut loose from the clogging influence of former inventions and our decision once wavering will be given in favour of that wider electrical industry which will have arisen. Now, it is not difficult to conceive of the present rivalry of nations in acquiring the most modern engines of destruction, giving place to a more wholesome national desire to possess the latest inventions for the wider use of electricity, especially if the importance of electric power as a commercial factor be admitted into the argument. At one time to be a great nation was to have command of the greatest army or navy, according to the geographical position of the country. Then the possession and use of arms was the hall-mark of authority, and claimed national recognition; now we stand at a period in the history of human affairs when a new force must be reckoned with, and, its potentialities in framing and moulding the destinies of a nation and ultimately of humanity, seriously taken into account. It is at this point that "A Lover of Justice" comes into touch with us, and his reasonings on behalf of "disarmed" peace enable us to support our claim to that high position to which we would assign the electrical industry in years to come. The writer to whom we refer systematically schedules his indictments against the bearing of arms by any nation, and these are strong enough individually to carry conviction to all thinkers on the subject, but for our purpose the financial aspect of the question must be considered, though obviously this would carry greatest weight in almost any argument. Of the cost of recent wars, the author states that the Franco-German War (1870) cost 1,200 millions, the American Civil War 610 millions, and the Boer War 250 millions. Of the expenses of the present Russo-Jap. War there are various estimates, but they are generally figured at nearly one million per week to both belligerents. A consideration of these colossal sums brings the writer to the methods of raising them, thus introducing National Debts. Under this heading if we disregard the "items" of other countries, and consider our own expenses, to quote the author, "our receipts from taxation (the only legitimate source, since loans have to be, in principle, paid back) are 131 millions and our expenses 243 millions. Our expenses, therefore, exceed our receipts by 100 millions. If we are (as we must be) 100 millions short every year, we must borrow 100 millions annually to pay our current expenses, and, in fact, we borrowed (old and new debts) 89 millions in 1903." From these figures a good idea of the cost of war is obtained while in alarming relief is also outlined that of "armed peace." It is this heavy expenditure of ours in supporting army and navy which calls down the wrath of "A Lover of Justice" on the head of militarism. With his proposition for the throwing down of her arms by Great Britain, we are not, as a technical journal directly concerned, nor do we claim to support so drastic a proposition, reasonable enough though it may seem. What we would emphasise is the growing importance of the electrical industry and the claims for greater national attention which it is making and should now receive. The article in question enables us to compare the influence on the community of national expenditure voted for the upkeep of army and navy, with that subscribed for the raising in our midst of a powerful factor in commercial affairs, namely a combination of electrical interests, having a constructive as opposed to a destructive object in view. It is certainly time that we took due notice of the stimulus to trade and commerce which is being occasioned in countries where hydro-electric plants are becoming widely installed. With such natural resources at command it is being realised that industries once ruined by the introduction of steam can now be revived by a judicious use of electric power. In other cases the increased rate of production possible with electricity as compared with steam gives the country using it marked advantages over commercial rivals not so equipped. It has been prophesied—and apparently with very good reason—that the great nation of the future will be that possessing and utilising to the full, for purposes of electric power generation and distribution, its natural hydraulic forces. This is a striking contrast to that ancient shibboleth, as now reflected in our army and navy, that "might is right" and consequently

by force of arms a nation maintained its position among other nations. Assume a country advantaged to the utmost of the benefits of hydro-electric power, socially prosperous, industrially hygienic, and thriving commercially; compare its assets with those of some world power rich in guns and fleets, rifles and armies. The first in possessing progressive means to social ends is constantly adding to the value of its stock, the second in creating destructive means to national ends ever lives in terror of its existence, and if engaged in conflict, defeats the objects of progress, leaving misery and bankruptcy in its trail.

Despite the present armed condition of the great Powers, there are repeated evidences of the folly of wars and the disastrous effect they have on human welfare. On every hand it is becoming clearer that armaments have served their purpose, and that having regard to the enormous expense they entail and the havoc they play their general abandonment would contribute materially to the progress of humanity. In contra-distinction to the baneful influence of wars upon the community, must be considered the benefits which science and especially electrical science can shed around. A portion of the money devoted yearly to the upkeep of our arms, both naval and military, would establish several large power houses for distributing electrical energy in industrial areas now begrimed and filthy under the sway of steam. We may pride ourselves on our greatness as a nation nurtured and developed by the aid of steam, but in justice to ourselves we dare not disregard the progress other countries are making in the use of hydro-electricity. When the strife between nations has ceased to become one involving the employment of arms, and when powerful navies shall avail us nothing in maintaining our trade, unless we develop, and that quickly, the natural power sources at our disposal, to a degree admitting competition with our rivals, we shall fall short of the standard of commercial greatness then prevailing. We can compete with the best hydro-electric plants by using the latest types of steam plant and installing very large units. It is true that, while dependent on coal, there are limits to our ultimate survival, but that need not concern us for the moment. Our duty, then, is obviously to take full advantage of those natural power sources we have, to raise our social and moral standard to bring us into line with countries more fortunately placed than we are and to fit ourselves for that struggle under those changed commercial conditions which are distinctly visible in the distance. Under this new *régime* the application of electricity to almost every industrial purpose will be a *fait accompli*, and the commercial welfare of a nation will depend upon the cultivation of this internal source of strength as opposed to an external method of defence.

Although national expenditure on armaments has increased to an alarming extent, and the influence of invention in social affairs hampered in proportion, we are optimistic enough to feel that the benefits of a judicious employment of electric power will ultimately appeal so strongly to the people of all countries, that in the natural course of things, moneys now devoted to the maintenance of armies and navies will be deflected into more permanently useful channels. This, of course, setting aside the chances of an untimely Armageddon which shall commit nations to their last armed appeal, and make havoc of all our achievements of the past and present centuries, in the social arts. It is this dread consequence of militarism which is so greatly feared and which gives rise to such an appeal as " A Lover of Justice " makes, for the disarmament of nations, but especially of Great Britain. In spite of this fear, however, and the fact that complete reliance is now placed on an appeal to arms, we feel that the evolutionary forces at work among nations, which wars and rumours of wars seem to affect but little, will render extreme measures unnecessary in ridding humanity of its present colossal burden of armaments. It seems probable that in the light of our present civilisation, and the state of reason to which the bulk of the people has been raised, the manufacture of weapons of destruction will no longer be justifiable. That wisdom which now prompts nations to disarm will avert the danger threatening them in the possession of armaments. The greater facilities for social advancement afforded by the development of industry

aided by the most modern machinery, will dispense with the necessities of building ships and training men to arms. The money will be needed in other quarters, while it goes without saying that the men will be needed too. The war which annihilates will give place to the sterner conflict of commerce with intelligence, invention and the application of natural forces to industry for its chief weapons. It is in this strife of nations that electricity will play the title *rôle*, and, as we have already indicated, the victory will be with that country making the most of its natural resources to maintain its position among its rivals.

THE INTERNATIONAL ELECTRICAL CONGRESS.

By the time this issue is in our readers' hands the great International Congress at the St. Louis Exposition will be in full swing. The importance attaching to this gigantic function can be gathered from the fact that almost 2,000 delegates will be present, representing every country in which electrical energy is used in some form or other, to a greater or less extent. The assembly of so many distinguished electricians cannot fail to have a beneficial reflection on the industry, as a universal factor of our time, both from the purely technical standpoint and the commercial. The influence now being exerted on human affairs by the wider industrial applications of electricity, will, we are convinced, be even more marked as a result of the deliberations of this meeting. Epoch-making in its essence it will be emphatically so in its practical bearing on national relations. Men who are estranged under political conditions, unite in the furtherance of a common object under the banner of science, and the feelings prompting this step are worthy of the highest commendation. The consequences of the International Electrical Congress cannot fail to make themselves evident throughout the civilised world, and America must be congratulated on the promotion of so laudable an object, and on the skill observed in carrying it into effect. From a study of the programme the arrangements have received the closest attention, to avoid delay or confusion, classification under section letters being made. We have already given particulars of these with the subject and chairman in a previous issue (No. 4, vol. i.). From a study of the list of papers of which 170 have been promised, we anticipate the greatest interest in Sections B, D, F, and G, dealing respectively with general application, power transmission, transportation, and communication. The remaining sections will doubtless be of considerable interest and value, but those mentioned have a more direct relation to the practical side of electrical engineering. Power transmission and traction are of incalculable value to the community as they strike directly at many of the greatest social evils. We shall look forward with no small degree of interest to the publication of these particular papers, a list of which will be found in the present issue.

As we have already announced we shall be exceptionally well placed in giving details of the entire transactions seeing that our Editor-in-Chief is with the Institution party. Despite the facilities the general public will have of obtaining all information possible through the medium of the Exposition Publicity Bureau, the report of the visitor is more valuable, less stereotyped. He observes what others, in constantly inspecting, overlook or, may be, deem unimportant. Further the systematic issue of news of exhibits will afford ample opportunity for the big things to get known. This we have taken careful note of, and such account as we hope to present to our readers will make every allowance for this spread of information on "big" things, and give full prominence to less hackneyed subjects. The tour has every prospect of a successful issue, and it will do much to bind us still closer, if that be possible, to our American electrical *confrères*, as well as to those of other nations whose delegates will attend the meeting.

Our Traction, Telephone, Students' and Central Station Practice Sections are of exceptional interest this month.

The Institution American Tour.

Notes on the Voyage.

At the moment of going to press, we have received the following notes from Mr. Theo. Feilden, our Editor-in-Chief, regarding the voyage of the Institution members to Boston, on s.s. *Republic*. "The passage was an excellent one, and our party was the life and soul of the ship, keeping all the first-class passengers entertained in great style. Electrical men have that happy knack of adjusting themselves quickly to their environment and in the present instance, we maintained our reputation as expert galvanisers. Conspicuous by their untiring efforts to render the journey agreeable and memorable were the following (alphabetically arranged): Lt.-Col. Crompton, C.B., Mr. Theo. Feilden, Mr. J. A. Foster, Mr. Robt. Hammond, Mr. F. Hope-Jones, Mr. E. H. Liebert, Mr. P. S. Sheardown, Mr. C. D. Taite, and Mr. G. Wilkinson; while Mr. R. Tree (Chief Clerk I.E.E.) worked indefatigably. On August 30 and 31, some excellent athletic sports were organised and carried out, the proceeds being in aid of the American Relief Society, Boston, and Seaman's Orphanage, Liverpool. The chief features were a tug-of-war England *v.* America, in which the English were victors, and an obstacle race. This was a most difficult event and caused great amusement; the winner was Mr. F. O. Mills, of our party, he defeating several American athletes who competed. The honours were on the whole fairly evenly divided. The 'obstacles' used were those made up for the Hon. Artillery Company on their voyage back from the States. A concert was also organised for August 31, and carried through with remarkable success. The programme was conspicuous for its variety, and it is reproduced herewith, as typifying the spirits of the party.

"Mr. Hammond's versatility was exemplified to a remarkable degree, and his urbanity coupled with his high spirits, largely contributed to the success of the voyage. The sums collected at the sports

PROGRAMME OF CONCERT.
BY KIND PERMISSION OF CAPT. JAS. MCAULEY.

Wednesday, Aug. 31, 1904. *Commence at* 8.30 P.M.

Chairman. LIEUT.-COL. R. E. CROMPTON, C.B.

Part I.

Pianoforte Solo . . . . "Polonaise"
MR. A. F. T. ATCHISON
Song . . . "Friar of Orders Grey"
MR. C. C. HAWKINS
Song . . . . "The Swallows"
MISS STOWER
Sketch . MR. J. H. GUTTERSON
Song . . . "Scotch Lassie Jean"
MRS. WOODBERRY
Song . . (1) "The Rose"
. . (2) "The River and the Sea"
MR. W. GEIPEL
Recitation . "Farmer Stebbins at the Bat"
MISS BURNES
Selection . . . "Men of Harlech"
THE INSTITUTION COMB ORCHESTRA

Part II.

Pianoforte Duet
MESSRS GUTTERSON AND WILKINSON
Song . . . . "A Double Loss"
MR. E. LIEBERT
Phonograph MR. WELLINGTON
Song . . . . "Language of Love"
MISS MABEL WOOD
Recitation . . "The Verity of Sayid"
MR. R. HAMMOND
Song . . . . "Mary of Argyle"
MR. THEO. FEILDEN
Sketch MR. J. H. GUTTERSON
Selection . . . "Swanee River"
THE INSTITUTION COMB ORCHESTRA
Accompanist. MR. GEORGE WILKINSON
AMERICA GOD SAVE THE KING

and concert in aid of the Institutions mentioned, amounted to £41 16*s.* 7*d.* The last event before making ready to disembark, was a dance given on the starboard deck on the night of the 1st inst. Professor John Perry, F.R.S., was the Master of Ceremonies. The decks were tastefully decorated with British and American flags, and lighted—impromptu in a very effective manner by the chief electrician of the ship. At the moment of departure for the tour in which we shall be hustled across the American Continent, we are in high spirits and look forward with keen interest to all that is before us."

In our next issue we shall devote special space to the Tour of the Institution in America, publishing notes and photos personally taken by Mr. Feilden. This matter will be of more than ordinary interest, and in view of the importance of the trip, will constitute valuable material for future reference. In this issue we give full details of the chief papers to be read before the most important sections of the Congress, and refer our readers to these. As we have indicated elsewhere, the gigantic gathering, from the four winds of electrical engineers, should be a huge success, and although Great Britain is but poorly represented among the Electrical Exhibits at St. Louis, she makes ample amends in the company of delegates and members of her Electrical Institution. We publish herewith a list of the members forming the party:

GRAY, R. K., London.
(*President and Delegate.*)
†CROMPTON, R.E., Lieut.-Col., C.B., London.
(*Past President and Delegate.*)
†PERRY, Professor JOHN, London.
(*Past President and Delegate.*)
MISS A. M. PERRY.
MISS A. STOWER.
†GLAZEBROOK, DR. R. T., Teddington.
(*Member of Council and Delegate.*)
†GRIPPER, F. E., London.
(*Member of Council.*)
†HAMMOND, ROBERT, London.
(*Hon. Treasurer and Member of Council.*)
MISS HAMMOND.
†*HARRISON, H. E., London.
(*Delegate.*)
†*DUDDELL, W., London.
(*Hon. Sec. to the Institution Delegation.*)
†ATCHISON, A. F. T., Birmingham.
†BALFOUR, GEORGE, London.
†BALL, R. S., London.
†BARNES, W. A., Manchester.
†BATES, D., Liverpool.
MRS. BATES.
†BLAIR, G. CONRAD, Paisley.
BLENNERHASSETT, R., Schenectady, U.S.A.
†CONNOLLY, JOHN T., Manchester.
MRS. CONNOLLY.
CORMACK, Professor J. D., London.
MRS. CORMACK.
†DICK, J. R., Brighton.
†EDGAR, JAMES, Wrexham.
†ERSKINE, R. S., London.
MRS. ERSKINE.
*FAWCUS, W. P. J., Manchester.
†FEILDEN, T., London.
†FOSTER, J. A., London.
†GEIPEL, W., London.
GOLDSBOROUGH, Professor W. E., Purdue, U.S.A.
HANDCOCK, E. C., Lynn, U.S.A.
HARRIS, W. A., Trindidad.
†HAWKINS, C. C., Bedford.
†HAYASHI, M., London.
HERING, C., Philadelphia, U.S.A.
†HESKETH, THOMAS, Folkestone.
MRS. HESKETH.
HIGMAN, O., Ottawa, Canada.
†HOPE-JONES, F., London.
INSULL, S., Chicago, U.S.A.
†JENNISON, M., Manchester.
KENNELLY, DR. A. E., Cambridge, Mass., U.S.A.
KERNOT, W. N., Melbourne.
†KIDMAN, F. C., Wallsend-on-Tyne.
KNIGHT, J. D., London.
†LIEBERT, E. H., Rochdale.
LLOYD, G. C., London.
(*Secretary.*)
†LONG, F. M., Norwich.
†LONGBOTTOM, B., Manchester.
†McLEOD, R. S., Manchester.
MAILLOUX, C. O., New York, U.S.A.
†MARR, J. L., Sunderland.
†MARR, W. B., Sunderland.
†MARSHALL, J., Cheltenham.
†MATTHEWS, R. B., Swansea.
†MILLS, F. O., Manchester.
†MORRIS, DR. D. K., Birmingham.
†MORRIS, J. T., London.
MORRISON, A. E., Prince Edward Island.
†MORSE, L. G. E., London.
†*NALDER, F. H., London.
NICHOLS, F., Toronto, Canada.
OWENS, Professor R. B., Montreal, Canada.
(*Local Hon. Sec. for Canada.*)
†PERRING, R. B., Buxton.
†POPE, W. G. T., Lisbon.
MRS. POPE.
†PYNE, A. P., Gateshead.
RICE, CALVIN, W., New York.
†RISCH, G. H. C., Johannesburg.
SCHATTNER, E. B., Schenectady.
SCOTT, E. KILBURN, London.
†SCOTT, W. H., Norwich.
†SHEARDOWN, P. S., Dublin.
SIMONS, H. B., Manchester.
SUMMERSCALES, W., Leeds.
†TAITE, C. D., Manchester.
(*Chairman, Manchester Local Section.*)
THOMSON, Professor ELIHU, Mass., U.S.A.
†TILNEY, M. J. E., London.
†TREE, R., London.
(*Chief Clerk.*)
WALLWIN, J. M., Manchester.
WARD, G. G., New York.
(*Local Hon. Sec. for U.S.A.*)
WEBB, A. C. F., Sydney, N.S.W.
†WHITING, H. G., Cork.
†WILKINSON, G., Harrogate.
WILLIS, CAPT. R. FF., Barbadoes.
MRS. WILLIS.
WILSON, L., Pittsfield, U.S.A.
†WOOLLAN, E. B., Tunbridge Wells.

* *An asterisk is placed before the names of past Members of Council.*
†*Denotes those sailing on the "Republic."*

Standards for Electrical Machinery.

THE Engineering Standards Committee has recently issued interim reports on generators, motors, and transformers, copper conductors and thicknesses of dielectric, and tubular tramway poles. Space will not permit of our publishing these in full, but we have already referred in previous issues to the work of the Committee. From the first report we gather that the results of the experiments carried out at the National Physical Laboratory to determine the safe limit of temperature at which electrical machinery can be allowed to work will shortly be published in full. We are, however, assured that, from the conduct of the experiments so far, the temperature limits to be recommended will be more liberal than those laid down by the American and German Electrical Standardisation Committees. The settling of standard electrical pressures did not cause as much trouble as was expected, and the proposed standard machines can be served by almost all the existing pressures, with an allowable variation of 10 per cent. on either side. The matter of frequency presented greater difficulties, and only after a conference held last January was 50 periods decided upon with 25 periods in a second category.

The Dangers of Overhead Wires.

THE extreme regard held by law and custom for the rights of the individual and for the protection of life and property in England has recently found expression in the decision given in the Brompton County Court in the case of Brown *v.* London and South Western Railway Company. Damages to the extent of £15 were obtained by a person for injury done by a broken wire on Putney Bridge. The evidence showed that the wire had parted at a joint which had been overheated when being soldered. It was held that negligence had been thus exhibited, and consequently, that the contractors were liable. It may, therefore, be anticipated that if damage be done to person or property directly or indirectly, by the negligent use or fixing of any overhead cable, or wire, pole, insulator, bracket, stay, binder, or other part of a circuit, the person, company, or employee of a public department charged with the execution of the work will be held responsible. In the present case the contraction of the wire by fall in temperature was supposed to have caused the wire to snap, so that in the erection of overhead structures, the influence of temperature and weather will have to be taken into account. It may, we do not say that it will, be that when a storm of more than usual severity occurs, and there is extensive wreckage of poles and wires, aggrieved persons will find grounds for bringing actions which will be very profitable. Provision for such claims cannot but make overhead systems expensive and we trust that our judicial authorities will adopt moderate views on liabilities of this description.

Chicago's Automatic Telephone Exchange.

CHICAGO can now boast the largest automatic telephone exchange in the world, and its recent opening for continued service marks an era in the annals of automatic telephony. The system adopted, that of the Automatic Electric Co., Chicago, deals with the down-town section of that city, an area of about two square miles. The exchange has a capacity of 10,000 subscribers of whom 8,000 are connected up and in operation.

The area served contains the Government and municipal departments, wholesale and retail stores, two large railway stations, and the chief offices and hotels. The whole district is undermined by the tunnel system of the Illinois Tunnel Co. through whose tunnels the cables radiate to their respective destinations. A recent issue of the *Western Electrician*, contained a long illustrated account of the installation, and we refer our readers to the Telephone Section of our May issue (vol. i. No. 5) for a description of the system. The cables are hung from the roof of the tunnels, which are normally used for sub-surface freight transport. Subscribers' connections are taken through pipes driven down into the tunnel, the distributing-box being placed in the building itself, and not in the tunnel as was previously done. The tunnels themselves extend a matter of twenty-two miles under the various down-town streets.

Mexico and Electricity.

THE possibilities of building up a business field for electrical apparatus in Mexico are apt to be overlooked in this country, and the distance separating us is probably looked upon as the chief barrier to trade. We contend, however, that where America, but especially Germany, can find scope for electrical enterprise, there also is room for British capital and labour. A glance at our Power, Traction, and Lighting sections this month, in which reference is made to Mexican and South American electrical projects, will afford convincing evidence of the strong position which American and German enterprise in electrical affairs is securing. We understand that the splendid trade methods of Germany have secured for her in South America a commercial standing which even Americans, with the advantage of proximity, have great difficulty in breaking through. What one country thousands of miles away can accomplish, may also be done by another, and having regard to the prospective activity in electrical matters in Central and South America it behoves us to secure for ourselves that recognition of our apparatus which its quality and design merit. Our experience in the Colonies should stand us in good stead for work of this character; and from our trade reputation we have nothing to lose and everything to gain by improving our commercial relations with the countries in question.

Dangers in Main Laying.

THE policy of electrical pioneers in laying cables in pipes has occasioned much expense in these days of paper insulated lead-covered mains, when the work of reconstruction, or it may be repair, is undertaken. Where high-tension cables were so treated and necessity to keep up supply irrespective of additions or repairs now compels men to work on the mains, the dangers of breaking into a pipe containing high voltage lines are of a serious character. The recent incident on the Metropolitan Electric Supply Company's mains in Manchester Square, in which a workman was killed through piercing a cable with a wedge driven into an iron pipe, is probably typical of the conditions under which supply is given by some of the older London companies operating with mains laid down many years ago. The fact of a man being set to break open with a wedge a pipe containing a live cable which presumably could not be shut down, points to an *in extremis* state of affairs on the network. In the provinces it is doubtful if any man would have been set to undertake such a task without first switching off the main, but London is peculiar in many things, and probably its methods with electric light mains are no exception to the rule. Even assuming the wedge could be driven "nicely" without piercing the insulation of the cable in the pipe, the act of breaking into the pipe with current on was sufficiently risky to warrant even ordinary precautions. We should have thought an experience of navvies accidentally piercing pipes with picks, and causing short circuits, would have afforded warning enough to those in authority of the extreme dangers of deliberately bursting a pipe containing charged cables. The very account must have caused the blood of many engineers in charge of high-tension cables to run cold!

The "Times" and the "Wireless" Correspondence.

In its issue of August 27, the *Times* published some valuable particulars of the operations of its "wireless" despatch boat *Haimun* in the Far East. The details of the erection and equipment of the Wei-hai-wei station and the boat are pregnant with interest and testify to the courage and determination evinced in face of difficulties. The de Forest Company whose system was used are to be complimented on its efficacy, and the distances over which messages were sent—the record being 210 sea miles—speak well for its manipulation. Apart from the very interesting facts that the vessel was the first to be employed on such an errand, and was also first in reporting a sea fight by wireless, the experiences of the boat and its system emphasise the difficulties of transmitting coherent messages when other systems are in operation. Before the memorable fight culminating in Makaroff's death, the *Times* correspondent writes: "We were very careful not to use our wireless telegraphy until the battleships were engaged with the Port Arthur batteries. If we had commenced to send news of the positions of the rival fleets we should at once have interfered with the wireless telegraphy of the belligerents." This is naturally a serious drawback to wireless telegraphy and its influence on the combatants may be judged from another salient sentence. "I am not sure it was not the constant use made by the Russians of their shore stations that prevented Togo from catching Makaroff's squadron outside." The Russians it seems, had been in the habit of "queering" the Japanese alphabet—all messages being in code—and only when they ceased, to receive a message from one of their own cruisers, was an interval afforded the Japanese in which to send their fateful message. It is interesting to note that both these messages were received by the *Haimun*, though, of course, in code. In all fairness the operators on the *Haimun* refrained from using their apparatus to the detriment of the opposing forces so that no matter how tempting an excuse may be found therein, the project could hardly have been condemned on technical grounds of interference with neighbouring instruments.

One-Phase Railway Trials.

Our readers will be familiar with the one-phase railway system developed by the Union Co. of Germany and tried experimentally on the Neiderschonweide-Spindlersfeld line for some months past. We understand that the Prussian State Railway authorities, with that characteristic enterprise of some continental Governments, have taken over the line for twelve months to experiment with the system, with a view to ascertaining its practicability for railway working. The system was described by Mr. W. M. Mordey in our February issue (No. 2, vol. i.). The line was temporarily taken over by the authorities on July 4, and a daily service of twenty-four trains each way will be run over the two and a half miles of route. A slight mishap occurred to one of the motor-cars early in August, but a continuous service has been maintained since. The deliberations of the railway authorities should make interesting reading.

We also notice that the Arnold electro-pneumatic railway system described by Mr. Mordey in our April issue (vol. i., No. 4) was tried over the experimental line at Lansing, Mich. The equipment partially destroyed by fire at the end of last year was used, the runs being over eight miles of the line. We understand that the complete efficiency of the locomotive was impaired on account of cracked castings, but speeds up to twenty-five miles an hour were attained. The practicability of collecting current from the single trolley line at 6,600 volts was demonstrated; speeds from the lowest to synchronism were obtained by the control system; the retarding and accelerating trials were also conducted satisfactorily.

The General Electric Company, Schenectady, have long been known to be working on a single-phase railway motor, but only during last month were the details of this made public, a trial trip being run over the Ballston Division of the Schenectady Railway Co. The car used was equipped with two bogie trucks, each fitted with two motors rated at 50 h.p. each. These are of the compensated series type, the special distributed field winding neutralising the armature reaction, the motors operating equally well with direct or alternate current. The trolley line is

supplied at 2,200 volts, this being reduced to 400 volts by an 80 k.w. air blast transformer carried on the car. The standard series parallel controller was employed, and the car run over a section of route with both a.c. and d.c. currents, careful records of the results being taken. Speed runs were made up to 32 miles per hour. We shall refer to this interesting system in a future issue.

The British Association Papers.

THE papers contributed to the Engineering and Physics Section of the British Association contain nothing strikingly novel, but were rather new phases of old themes. Despite the charm which attaches to all matters metaphysical and electro-physical, the hard facts of the engineers seem to appeal more to the average mind than do the hypotheses of the metaphysician, or the calculation and experiments of the electrophysicists. The results of experiments in spheres more closely allied to active commerciality claim greater attention, and it may be respect. than the less readily understood reasonings and labours of those who are after all in the van of progress. Despite all that may be said to the contrary, there is something stimulating in the speculations of a Prime Minister, based, as they were in this case, on the latest scientific discoveries regarding matter. Even if we are only taught to reflect upon matter as a delusion, there is a satisfaction in feeling that the problems, social, moral, and physical, which torment us, may be classed with that from which they apparently spring. Whatever be said we owe much to men who can think—and deeply—upon the ever-increasing complexity of living things, and place their thoughts at the disposal of humanity.

Of the papers presented to the Engineering Section those dealing with the internal combustion engine and gases, by Mr. Dugald Clerk, Prof. B. Hopkinson, and Prof. H. B. Dixon, must attract the greatest attention. The former suggested a method of increasing the mean pressure in a gas-engine cylinder without increasing the temperature, by admitting the cooled exhaust gases with the cylinder. The author indicated that if the atmospheric pressure were double what it is, for a given temperature the exploding pressure of a gas would be doubled and non-compressing engines would be more successful. He pointed out that the present compression motor was a necessity arising from an atmosphere of small density. The results obtained by enhancing the atmospheric pressure were sufficient to dispense with water-cooled pistons, now becoming a feature of large modern gas-engines. Prof. Hopkinson's remarks on the "Calorimetry of Gases exhausted from Internal Combustion Engines," together with those of Prof. H. B. Dixon on his experiments with specific heats of gases at high temperatures, are worthy of close study in conjunction with those of Mr. Dugald Clerk. The commercial possibilities of the gas-engine are of such importance to the electrical industry that the most recent thought and experiment on what is fundamentally a very abstruse subject deserve the most careful attention at the hands of engineers.

Power Supply on Tyneside.

THE growth of the Newcastle-on-Tyne Electric Supply Co. as outlined in Mr. T. H. Minshall's article published this month, illustrates in a remarkable manner how a small concern, if properly handled, can develop, in spite of that tendency peculiar to the electrical industry to raise the scrap-heap of a supply station to alarming dimensions. Opened in 1891 under the conditions of supply then prevailing, the Pandon Dene Station furnished one-phase currents under difficulties now practically unknown in central-station work. Progress, however, brought a change which at present finds expression in the two large stations, Neptune Bank and Carville, engaged in distributing energy in bulk over a wide area on the Tyneside. In comparison with American and Continental engineers we are severely handicapped in transforming our natural resources into electrical energy, and distributing them broadcast in this form. Steam so far has been our chief ally and as a competing country availing ourselves to the utmost of such natural powers as we command, we have been compelled to improve steam using plant, as required for electrical purposes, to a degree admitting of its industrial

employment under conditions which equalise our commercial status with that of our foreign competitors. A company then, such as the Newcastle-on-Tyne Electric Supply Co., essaying to afford the industries in its neighbourhood privileges which are enjoyed beyond our shores, is compelled to utilise only that class of plant permitting of the reliability of water-power combined with an equivalent economy. Hence the occasion for the marked changes noticeable in its supply plant in the last few years alone. The labours of this great organisation, born among electrical pioneers and now vitalised into an activity which few can rival, will be watched with the keenest interest during the next few years. Not only has it grasped the necessities of supply in bulk from the generation point of view, but it has also firmly taken hold of its consumers' department, and, by pursuing a vigorous propaganda, bids fair to improve its load factor and maximum demand to a point which will spell "extensions" before long. The work of advertising and canvassing, although a new feature of electricity supply, will become stereotyped in time, and will not be the same object of interest as the generating plant will be in a few years. Will the history of the company with steam be repeated with the gas-engine, and the same story told through reciprocating-engine and direct-coupled dynamo to that much-desired unit, the gas turbo-generator? Or can we picture a future company with plant at the pit's mouth utilising the heat of coal to directly generate electrical energy? Of one thing we are assured, the company will spare neither time nor money to acquire that form of plant which shall assure the greatest reliability with the highest economy, to the common advantage of both supplier and consumer.

London's Post Office Telephone Mains.

THE laying of telephone mains in the streets of London amidst the masses of pipes and cables already put below ground has proved no mean task, and the method of its accomplishment speaks well for the engineers responsible for the work. The *résumé* by Mr. W. Noble, which we are now publishing, gives but a partial insight into the difficulties encountered and overcome, though, from his account, most engineers responsible for the laying of cables, and especially those for telephone work, will at once comprehend the nature of the task. Apart from the traffic conditions which are peculiar to London, the congested nature of its underground system introduced factors with which only experience and skill could cope. The laying of mains of any description is an easy enough matter—on paper—and the mains surveyor, reviewing the position on his office table, makes light of "stowing away" a line of ducts or a few dozen cables. It is the engineer who bears the brunt of that extra labour occasioned by striking "pipe nests," sunken cellars, old sewers and water mains, in addition to the minor troubles of clearing services of all kinds, "placing" joint boxes, and timing the work to the traffic. Due credit is never done to the man who, presumably acting on the instructions of his superiors, is surmounting, frequently unknown to them, difficulties unforeseen in the original plans for the work. We hope that Mr. Noble's articles will prove valuable to telephone men in particular, and to central-station engineers in general. To the former, even though they can never perhaps have such a task before them, the manner in which London's Post Office telephone mains were laid, may contain for them some useful hints for further reference. To the latter, the work should present features not unknown in their particular sphere, and difficulties overcome in ways which might well apply to theirs, if modified to the instance in question.

Electrical Fires.

WE have from time to time drawn attention to the manner in which the lay press repeatedly attributes any fires occurring in buildings wired for electric light, to the "fusion of electric wires." This foolish cry has met with continued condemnation from the electrical press, but it is still to be seen even in papers which should presumably know better. The notion of the average public who regard anything electrical as highly dangerous, has been too frequently

encouraged in this foolish manner, and we are glad to notice evidence from America, which, if widely circulated, will help to dispel this popular fallacy. Our esteemed contemporary *Electricity*, New York, in an editorial on the subject, analyses the matter from all points. It points out that at the fuses which are generally the scapegoats, arcing of a destructive character cannot take place on account of the extreme precautions now taken to enclose these devices. This throws the cause of fires back on to the wiring, which has been frequently said to set fire to mouldings. A report from the Committee of Arts and Sciences, published in the journal of the Franklin Institute, on Fennell's apparatus for fireproofing wood, however, sets this argument aside, and as our contemporary states, "a building entirely dependent on electricity for its light, heat, and power is by far the best insurance risk the community can offer." From other sources which have had the investigation of this matter in hand, we hear that the fires so often attributed in the lay press to electricity, have been traced to entirely different sources. It is high time that the stigma so carelessly cast on electric lighting by a press too ready to give publicity to hastily formed opinions, be removed once and for all.

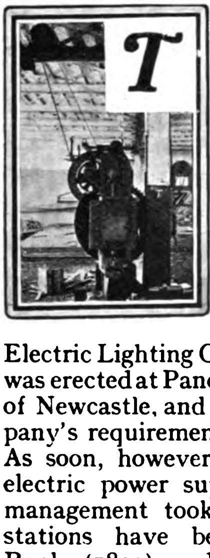
The Ohio Electric Light Convention.

THE electrical industry in the United States is so well represented by associations that it is a matter of some difficulty to put on record the doings of all these at their annual "meet." It speaks well for the electrical business that these combinations of interests should have sprung up and made their voices heard throughout the land, and we might say, the earth, seeing that the dissemination of literature is now undertaken on such a wide scale. The Ohio Electric Light Association held its tenth Annual Convention at Sandusky, Ohio, on August 16, 17, 18, and the proceedings reported indicate that a successful gathering was the result. The President in his address made an outspoken plea for better records and fuller detail knowledge of the operation of central stations. He contended that meter losses had been argued, and the incandescent lamp talked down to 3.1 watts, while the iron in transformers was tired of ageing. These matters were well enough if discussed to a limit but without statistics and operating records, it was impossible to tell what was being done. He was sorry to see that many stations fixed their charges by comparison of certain companies' rates, and from these he deduces his own particular figures, instead of ascertaining what his actual costs are, and acting according. By a good sub-divided system of accounting the operating costs could be easily arrived at, and until these were known it was impossible to fix rates for current. In a number of interesting instances, which for lack of space we must omit, the President pushed home his argument for good record keeping, and we must heartily endorse his advice. We do not say that records of our own stations are not kept, but in many instances they are not well kept. Over here, no doubt, the President's remarks do not apply to the same extent, but we refer to them in the hope that they may prove valuable. The papers read before the Convention were all much of the usual stamp, and until we see a more detail report we cannot comment at length upon them. We understand from the *Western Electrician* that the attendance of central station men was small, too small considering that Ohio has at least one hundred and fifty lighting companies in operation. We notice also that a paper down for reading, on "Central Station Heating," was abandoned on account of the non-appearance of the authors.

The Central Station Practice Section this month is of exceptional interest to engineers whether in the power house or on the mains.

THE NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY COMPANY, LIMITED.

By T. H. MINSHALL, M.I.E.E.



THE Newcastle-upon-Tyne Electric Supply Company commenced operations in the year 1891, when it acquired the right to become joint undertaker with the Newcastle and District Electric Lighting Company under the Newcastle-upon-Tyne Electric Lighting Order of 1890. A station was erected at Pandon Dene, near the centre of Newcastle, and this answered the company's requirements for nearly ten years. As soon, however, as the possibilities of electric power supply were realised, the management took it up, and additional stations have been built at Neptune Bank (1899) and Carville (1904). The undertaking has gradually been extended until the area of supply authorised by statute or by agreement is now 625 square miles in the counties of Northumberland and Durham, with the important industrial district of Tyneside as a centre. During the past six years the capital outlay has increased from £100,000 to £1,115,000, a steady dividend of 8 per cent. being paid thereon, while the original installation has been written off at a cost of £100,000.

In the following article it is proposed to give a short description of the company's system, growth, and development, beginning with the means of generating electricity, then describing the methods of transmission and distribution, including some account of the uses to which electricity is being put by the various classes of consumers, and concluding with a short study of the causes which have enabled the company to attain its present position as the pioneer power scheme of this country and the financial results it has obtained.

Generation of Electricity.

The three stations described in this article may, to some extent, be considered as typical of the various periods of development in station design :

(1) Pandon Dene. The station of fifteen years ago.

(2) Neptune Bank. An average station of to-day.

(3) Carville. Typical of the designs which will probably be followed in the immediate future.

Pandon Dene Station, 1889–1899.

The original station at Pandon Dene (Fig. 1) was commenced in the year 1889, and first supplied current on January 31, 1890. The plant then consisted of two 200-h.p. engines, each driving an alternator of 100-h.p. capacity by means of ropes. Single-phase alternating current at 100 periods per second was supplied at a pressure of 2,100 volts to transformers on the consumer's premises, where it was reduced to 100 volts. Steam was

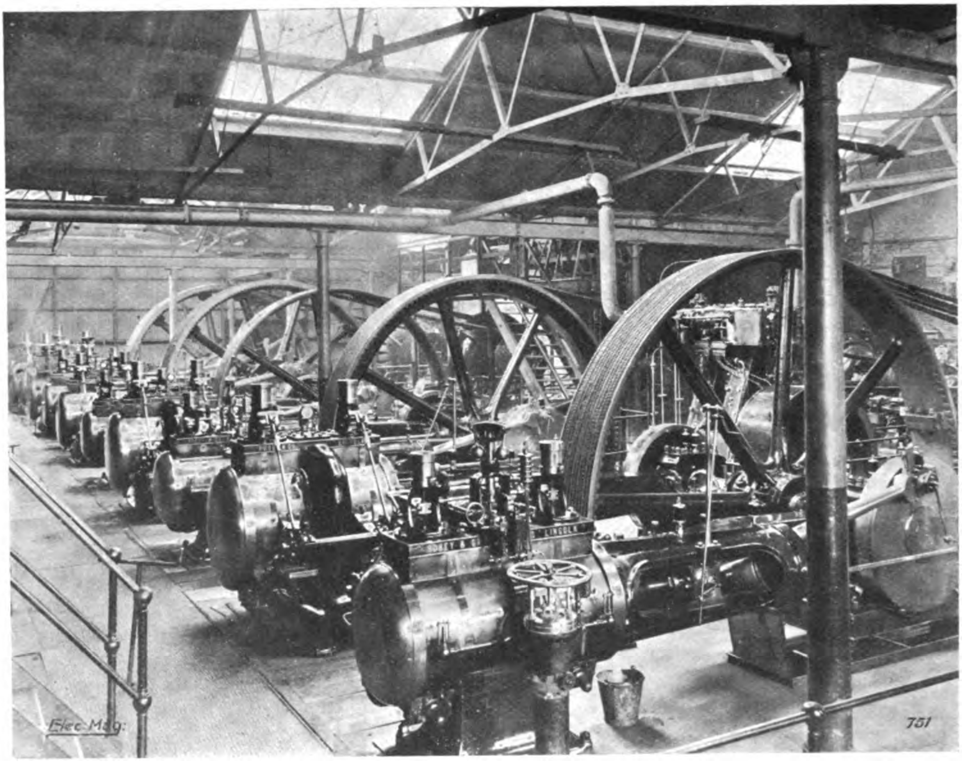


FIG. 1. PANDON DENE STATION.

generated by two Lancashire boilers, but neither condensing plant nor economisers were used. The switching arrangements would now be considered somewhat primitive, although the switchboard, which was burnt out in March 1890, was at the time considered to be the finest in England. No ammeters were used to read the load previous to the accident, a dynamometer being put in circuit when it was required. In short, the station was fairly typical of the electrical development at that period.

From the commencement of supply the load rapidly increased, reaching in December 1890 a maximum of 193 h.p. From this time onwards the progress steadily continued, until by the end of 1899 the plant installed consisted of nine Lancashire boilers, one 75-h.p. engine and alternator, three 200-h.p. engines and alternators, two 400-h.p. engines and alternators, with condensing plant and economisers, the maximum load in the winter of 1899 being 1,043 h.p.

Towards the end of the year 1899 the directors realised that their system of supply, although quite satisfactory for lighting, was not suited to meet the growing demand for power, and they decided to give, in addition to the alternating current, a direct current supply. For this purpose two 500-h.p. direct current machines were put down, and a system of direct current mains was laid in the city. It was further decided gradually to change over the consumers from alternating to direct current supply (which has since been done), so that the single-phase system might ultimately be discarded. By the end of 1900 the load at the Pandon Dene Station had reached 1,600 h.p., and was increasing so rapidly that it became evident that before long the demand would outgrow the capacity of the station. The directors decided for this and other reasons that it would be advisable to erect a large station outside the city in a situation more suitable for economical production, and the Neptune Bank Station, which is de-

scribed below, was the outcome of this decision.

Neptune Bank Station.

Neptune Bank Station was erected by the Supply Company in conjunction with the Walker and Wallsend Union Gas Company, who had obtained powers for the supply of electricity "in bulk" in the Wallsend district. It commenced to supply current to neighbouring consumers in December 1900, but it was not until December 5, 1901, that it began to supply current to Newcastle, to assist Pandon Dene Station. From that date it gradually took over the load on the Pandon Dene Station, and the latter finally ceased generating in the spring of 1903, since when it has been used as a sub-station only.

The Neptune Bank Station and the electrical undertaking of the Gas Company was entirely taken over by the Supply Company in the year 1903, under powers conferred on it by special Act of Parliament. The Neptune Bank Station (Fig. 2) was designed to supply three-phase current at a pressure of 5,500 volts and a periodicity of 40 cycles, and represented a great advance upon the design of the Pandon Station. At this pressure the current is transmitted to the various sub-stations in Newcastle and district, where it is transformed down to a pressure of 240 volts direct current for lighting, and 480 volts for power. In addition, however, to the supply of direct current, a number of large consumers are supplied with three-phase current as well, as being more suitable for certain of their requirements.

Present Equipment. — The dynamos first installed were driven by marine engines, the later ones by turbines.

The present equipment consists of ten Babcock and Wilcox boilers, one 75 and two 300-h.p. direct-current generators driven by Belliss engines, four 1,200-h.p. three-phase alternators driven by triple expansion marine-engines, and one 3,000-h.p. Parson's three-phase turbo-alternator.

The switchgear is of the same form as that used at Carville and described later, being of the cellular type with concrete walls and chambers, and is operated electrically. Except for this feature

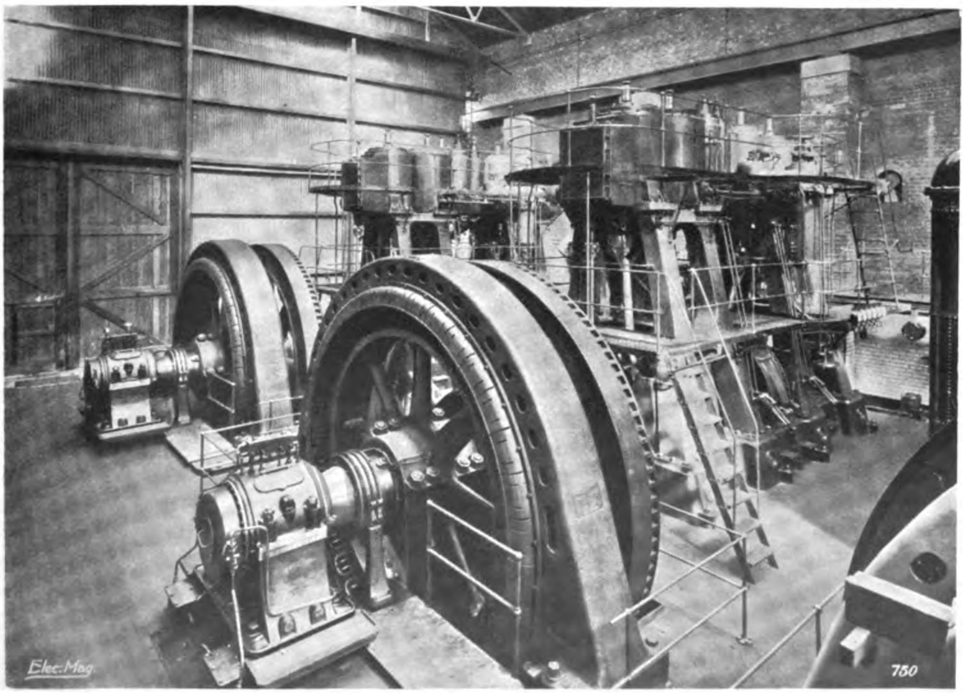


FIG. 2. NEPTUNE BANK STATION.

which is somewhat novel, the station equipment may be considered as fairly typical of the average power house of the present day.

Carville Power House (1904).

It had always been realised that it would not pay to extend the Neptune Bank Station indefinitely, and at the end of 1902 it became evident that the time was approaching when it would be necessary to build a station of the most modern design capable of being extended to meet all the company's requirements for many years to come.

This decision was hastened owing to the necessity of meeting the demand of the North Eastern Railway Company, with whom the Supply Company had contracted for all the energy required for working the suburban lines and for driving and lighting the railway company's workshops and stations in the district.

The foundations at Carville were commenced in April 1903, and current was first supplied to the company's system on July 1, 1904. Carville embodies the very latest practice in power-station design, and special attention has been paid to security of supply combined with low capital cost.

The arrangement of plant in a power-station at the present day offers a wider and more important field for improvement than any other branch of electrical supply. Hence the arrangement of Carville is particularly interesting. While the design as a whole presents several unusual features those of the greatest importance are, perhaps :

(1) The subdivision of the station into what is, practically speaking a number of independent stations.
(2) The adoption of steam turbines larger than any in use at the time.
(3) The use of water-tube boilers of the marine type.
(4) The use of automatic oil-break switchgear of the cellular type, worked by electricity.

General Arrangement.—The site has a frontage of 420 ft. on the River Tyne, which enables an ample supply of con-

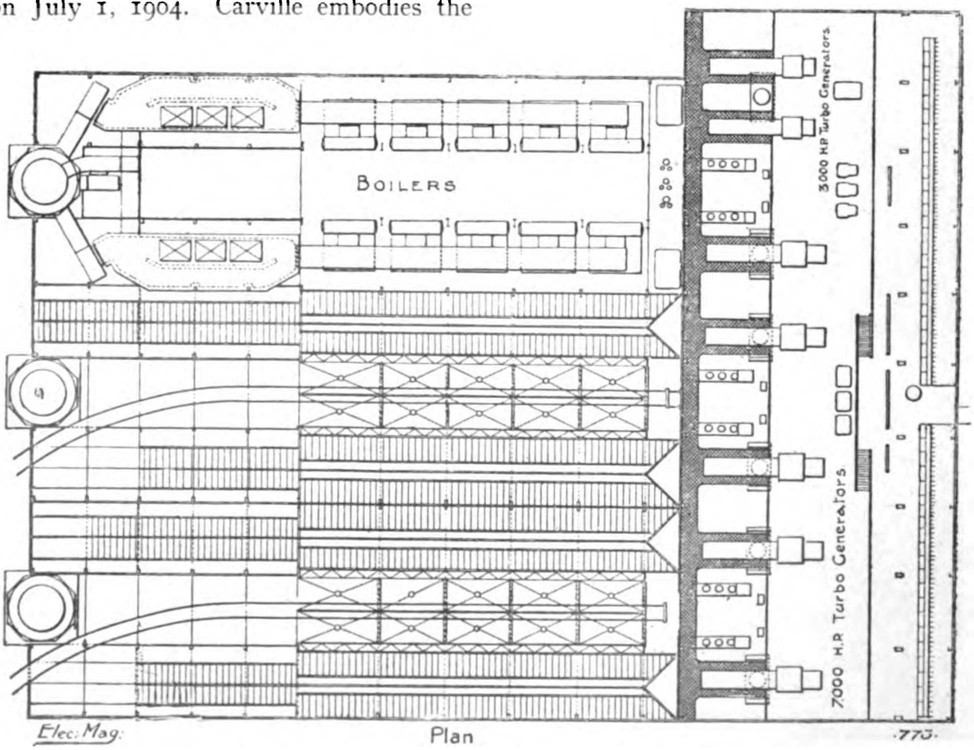


Fig. 3. Plan of Carville Station.

densing water to be obtained. The stores, time-office, smiths' shop, &c., are situated at some distance from the boiler-house fronting on the road and railway, and in such a position as to admit of their extension and that of the boiler-house without interference. The engineer's offices are situated in a separate building in the rear of the switch gallery.

The small floor-space occupied by the turbines compared with the boilers rendered it desirable to place the boiler-house at right angles to instead of parallel with the engine-room. This arrangement, moreover, reduces the length of steam-piping to a minimum, and, in the event of a larger size of generator being adopted in future in the engine-room, makes it possible, by increasing the length of the future boiler-house, to instal the extra boiler power required without interfering with the general design of the station (Fig. 3).

(1) *Complete Unit System.*—The station is laid out on what is known as the complete unit system, that is to say, each of the larger turbo-alternators has its own condenser, exciter, set of boilers, pumps, &c., but it shares with another large set a common boiler-house, coal-bunker, chimney and branch railway siding.

Thus, the only points of junction common to all the units are the main electrical busbars, the circulating water system, and the main railway siding.

The adoption of this design has been brought about by the increasing size of power-stations and the greater attention given to the avoidance of break-downs.

Advantages of Complete Unit System.—With it security of supply is increased, as the effects of a failure in any part of the machinery are confined to one unit. At the same time economy of capital expenditure results from the fact that money need not be spent at the outset upon buildings, chimney, &c., to allow for future extensions; each unit is completely equipped at the start. Extensions are simplified, as the new units may, without interfering with the symmetry of the station, consist of any type or size of plant which engineering development may render desirable.

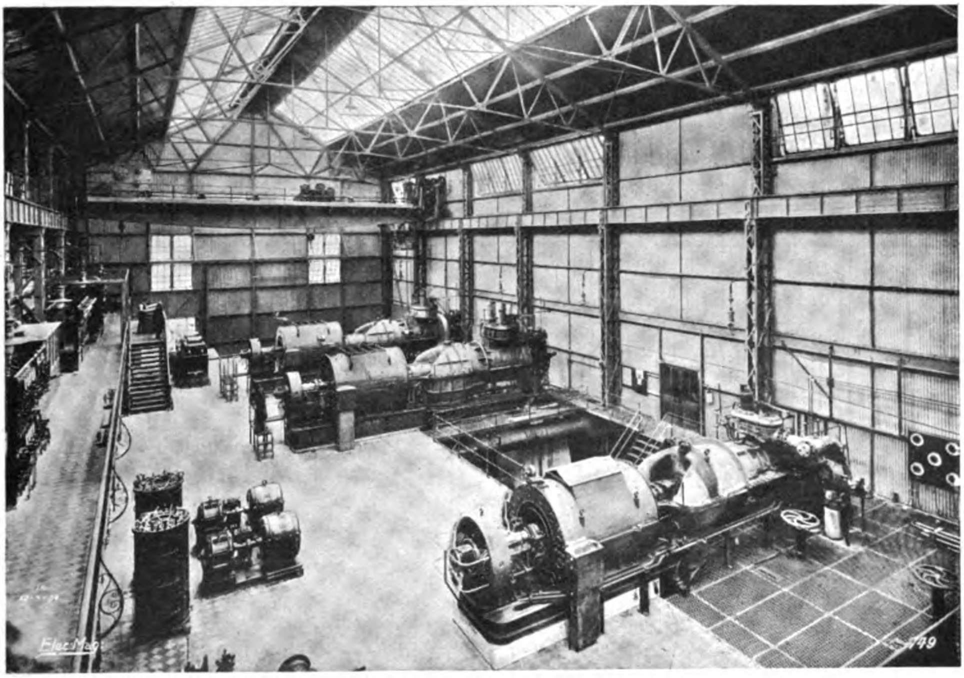


FIG. 4. ENGINE-ROOM, CARVILLE.

(2) *Adoption of Steam Turbines.*—After carefully considering the various methods

of generation, it was finally decided to adopt steam turbines of the largest size then available. This was largely the result of the favourable experience already obtained from the 3,000-h.p. turbines which had been in use in Neptune Bank for the previous two years, and which had been found to admirably fulfil the two essentials (security of supply and low capital cost), besides being extremely economical in steam and cost of maintenance.

The steam turbine possesses three other advantages which are of great importance in connection with the economical generation of power :

(*a*) Capacity for large overload—a matter of great importance in a station like Carville, which has to supply a great variety of loads of constantly changing magnitude. The machines at Carville can deal with overloads of 100 per cent. without difficulty.

(*b*) Uniform turning moment, which renders the operation of a large electrical system much easier.

(*c*) Absence of internal rubbing surfaces, which removes the necessity for lubrication, enabling the exhaust steam to be kept clean and returned to the boilers without filtration.

Present Equipment.—The present equipment at Carville consists of two 3,000-h.p. turbo-alternators and two 7,000-h.p. turbo-alternators (Fig. 4).

Steam Consumption.—Tests show that with steam at 200 lbs. superheat 150° F., the steam consumption of the large turbo-alternators does not exceed 11 lbs. per e.h.p. hour at the most economical load.

Auxiliaries.—The condensers and other auxiliaries are placed below the turbine, but in such a position as to be entirely accessible to the overhead crane.

Although the turbines at present installed are of the horizontal type, the head-room in the engine-room has been designed so as to allow turbines of the vertical type to be installed in the future if found desirable.

Alternators.—The alternators generate three-phase current at 40 cycles and 5,750 volts, and have exciters fixed on the end of their shafts.

(3) *The Use of Water-tube Boilers.*—Each boiler-house contains ten water-tube boilers of the Babcock marine type in two separate banks of five, each bank being sufficient to supply one of the large sets with ease.

The advantages of this type of boiler are, the small space occupied, and the absence of air-leakage, due to the boiler being enclosed by steel plates.

Coal Handling.—The coal-handling arrangements are very convenient. Each boiler-house has a separate bunker, into which the coal is discharged from an overhead siding, on to which the trucks are drawn by an electric locomotive. Independent shoots deliver the coal through weighing machines to the automatic electrically driven chain-grate stokers in front of the boilers. The ashes are removed by means of a conveyor discharging into trucks so that both coal and ashes are handled mechanically throughout.

Pumps.—The feed-pumps are arranged to work without lubrication, so that the discharge from the condenser may be passed direct into the boilers.

(4) *Switchgear.*—This is of a type somewhat new in this country, though likely to be much used in future. The increased powers to be handled necessitated a totally different form of switch from that formerly employed, a main switch in a station like Carville having possibly on occasion to break 20,000 h.p., or more.

The ideals aimed at in designing the switchgear were :

(*a*) The switches, interconnecting cables and all auxiliary apparatus for the various machines and outgoing feeders, as well as the different phases of each circuit, were kept absolutely separate by fireproof partitions.

(*b*) The switch-house was made absolutely fireproof.

(*c*) Every portion of the switchgear was capable of being isolated from the remaining apparatus for purposes of overhaul and cleaning.

(*d*) Extension was rendered easy.

These conditions have been satisfied,

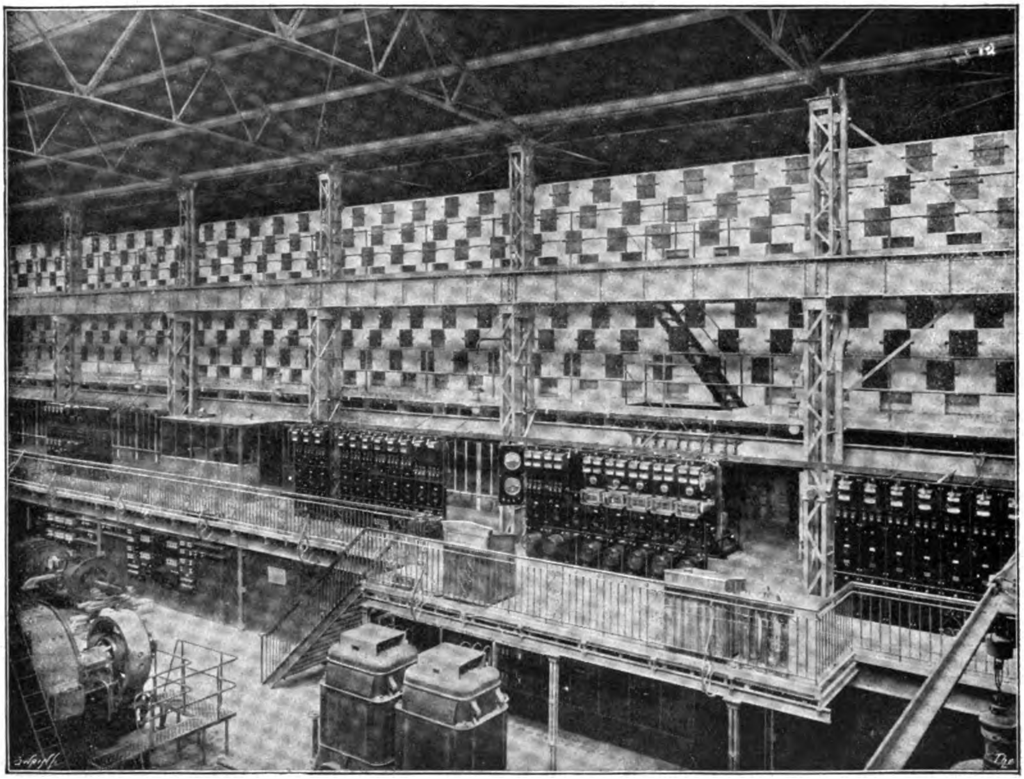


FIG. 5. SWITCH GEAR, CARVILLE STATION.

but to do so necessitated a board equal in length to the engine-room (Fig. 5). There are four galleries, the lowest being level with the engine-room floor, and below this is a cable basement. The two top galleries each contain a set of "busbars," the main switches are on the next, the ground floor being occupied with instrument transformers, &c. All cables proceed from the basement to the busbars at the top through vertical cells, which are built on to a wall running the entire length of the switch-house from top to bottom on each gallery. The cells and wall are built up of concrete slabs. The busbar chambers and the switch cells, which face the engine-room, are completely enclosed by iron doors, and instrument transformers are also placed in separate closed chambers.

The main switches "break" and "make" in oil, but there is an auxiliary contact in air, and each switch is operated by a small motor, which is controlled from a distance by a small switch on an independent operating board. The operator has thus nothing to do with the high-tension connections at all, an arrangement with obvious advantages. Automatic protective devices are supplied for isolating excessive overloads, and a complete service of compressed-air pipes is installed for cleaning. All high-tension connections are covered with rubber, but depend for insulation on porcelain insulators.

Distribution System.

Parallel with the extension of the undertaking and the enlargement of the means of generation, the system of distribution has also grown, and there is at the present day a network of mains extending from North Shields on the east and as far as Elswick on the west—a total distance of eleven miles. The original system of mains consisted of concentric lead-covered armoured cables laid in pipes or direct in the ground. During the past few years the whole of this original network has been replaced by a three-wire direct-

current system, while in certain parts of the district where the three-phase system of supply is given, three-core paper insulated lead-covered cables laid on the solid system are used.

The method of distribution consists, broadly speaking, in the transmission of current at a pressure of about 6000 volts through paper-insulated lead-covered cables to sub-stations, where it is either converted into direct current at low tension or is transformed as three-phase current to a pressure suitable for the consumer's use. The network of high-tension cables consists throughout of paper-insulated cables laid solid in almost every instance, earthenware or wood troughing being used in some places, and cast or wrought-iron troughing where special protection is necessary or where the cables have to run above-ground.

The following is a list of the sub-stations :

No.	Used for.
5	N.E.Ry. traction
5	Supply in Newcastle
1	Supply in Benton
11	Supply in Wallsend and Willington
7	N.E.Ry. power and lighting scheme

Three of the last mentioned only are actually at work.

That at Pandon Dene (Fig. 6) is the largest sub-station and contains over 4,000 k.w. of plant. The switchgear used in the largest sub-stations is of a somewhat similar pattern to that adopted in the Carville power station, the switches being controlled from a distance and electrically operated, while in the smaller sub-stations high-tension switchgear of the Brown-Boveri type has been used. Certain of the sub-stations have no rotary apparatus, being used for supplying three-phase current exclusively.

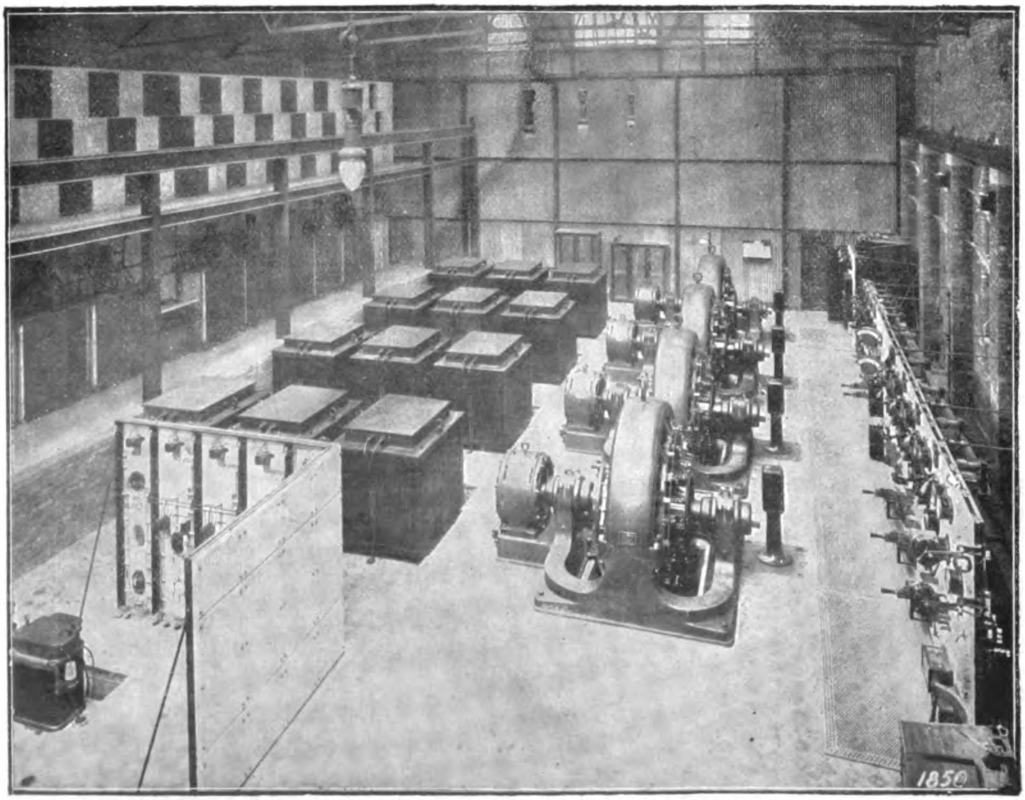


FIG. 6. PANDON SUB-STATION.

Company's Customers.

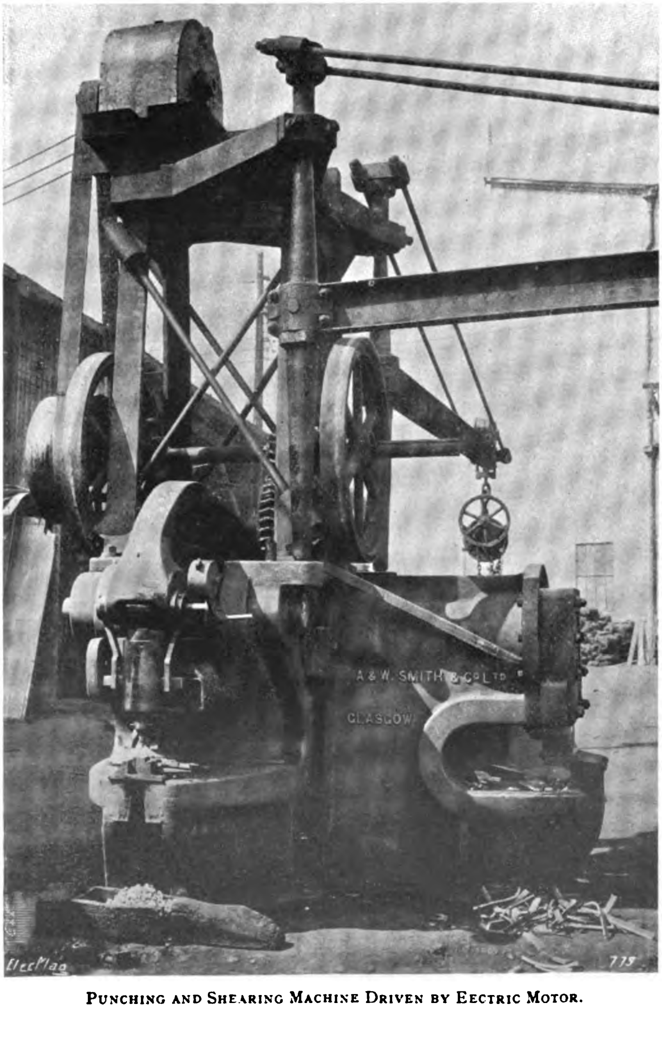
The Newcastle-upon-Tyne Electric Supply Company probably supplies a greater variety of customers than any other system. As already mentioned, it originally supplied lighting only, but it is now generating electricity for the Tyneside tramways, North Eastern Railway, and almost every form of factory. The connections to the consumers at the present time are about 27,000 h.p., the amount of power supplied to each of the respective classes of customers being as follows:

	Horse-power.
Manufacturers	about 7,500
Small motors	,, 2,000
Lighting	about 7,000
Traction	,, 8,500
Bulk supply	,, 2,000

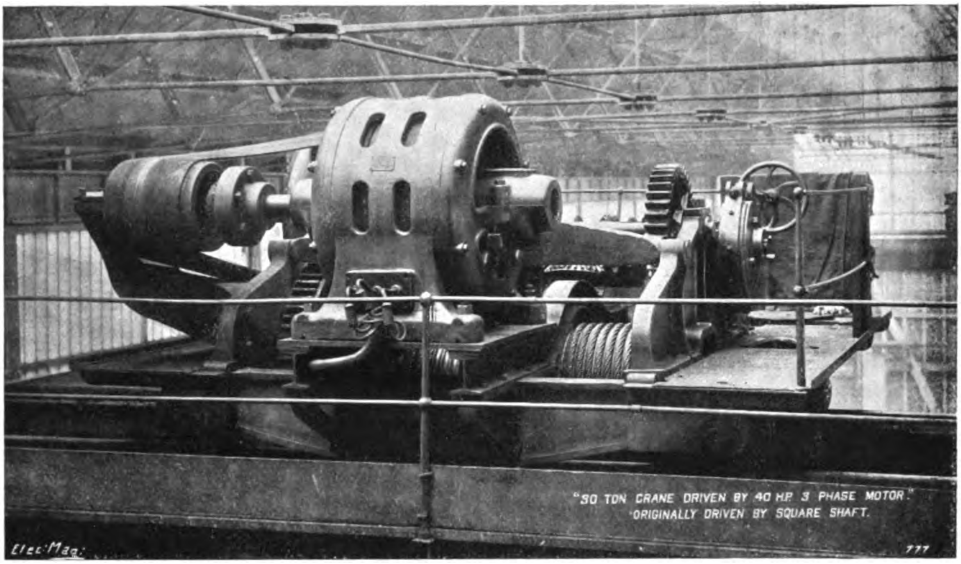
Particulars of Manufacturers' Installations.—The first large manufacturer was connected to the system at the beginning of 1901. The following is a brief description of some of the leading manufacturers' installations.

Hawthorn Leslie's, St. Peter's Works.—Throughout these works the motors are of three-phase induction type, supplied at 440 volts, the principal feature of interest being the cranes, all of which, with the exception of two recently installed, have been converted from square shafting. The total number of cranes driven electrically amounts to sixteen, fourteen of which are driven by means of single motors of the short-circuited rotor type, the other two being provided with three motors—one for each motion—the motors in these cases being of the variable-speed type, provided with slip-rings used in conjunction with a controller. The remaining portion of the installation consists of motors driving all classes of engineering tools and line shafting; an air-compressor being driven by a 75 h.p. motor. The shop lighting is all done by arcs of 5 amp. size (enclosed), working two in series across 240 volts.

Swan Hunter and Wigham Richardson, Walker Yard.—The motors in this yard are of Westinghouse and Thomson-Houston manufacture, all of the three-phase induction type, supplied at 440 volts, with the exception of those on the engine works cranes. All the shipyard winches are operated electrically, and are capable of

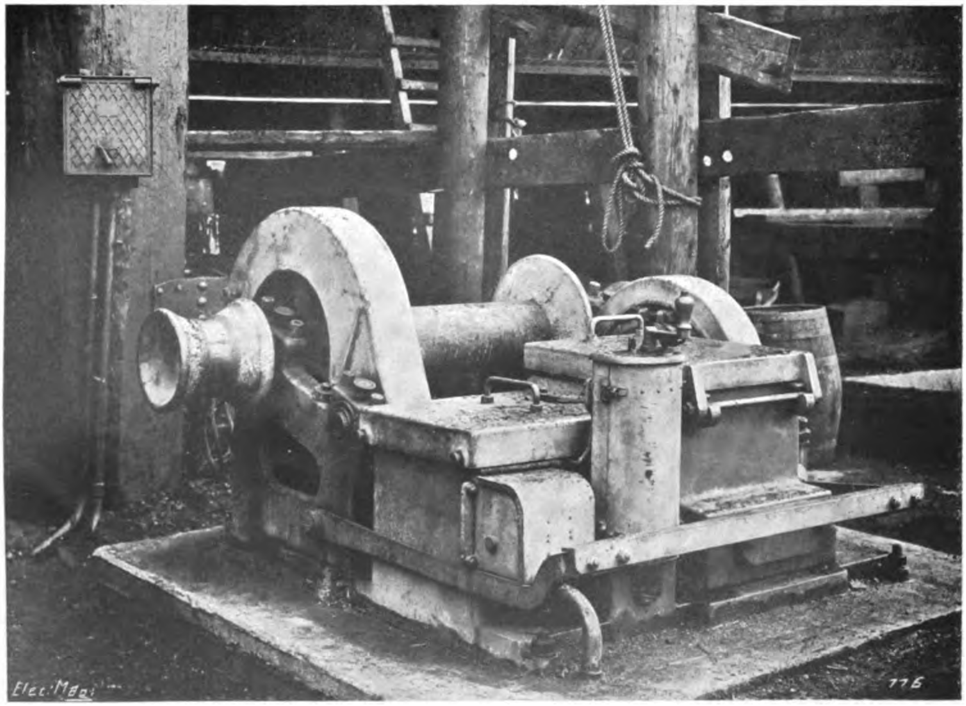


PUNCHING AND SHEARING MACHINE DRIVEN BY EECTRIC MOTOR.



30-TON CRANE, DRIVEN BY 40-H.P. THREE-PHASE MOTOR.

lifting three tons at a speed of 50 ft. per minute direct off the barrel, and of running in either direction at varying speeds. The winches are of MacTaggart Scott's manufacture, the motors being of the wound rotor type fitted with slip-rings and provided with controllers and resistances, mounted on the winch frame.



ELECTRIC WINCH.

Northumberland Shipbuilding Company.—All motors are of the induction type, supplied at 440 volts. Winches of Ransome Rapier and MacTaggart Scott's manufacture (similar to Swan Hunter and Wigham Richardson's).

This firm has recently had installed three Massey power-hammers of the following sizes: 3 cwt., 5 cwt., and 10 cwt., to replace the steam-driven hammers. Each hammer is driven by its own motor, the motors being mounted on the frame of the hammers and driving through spur-gearing. There have also recently been installed two 75 h.p. motors for driving pumps for the hydraulic tools, and one 125 h.p. motor for driving an air-compressor for the pneumatic tools in this yard.

Sir W. G. Armstrong Whitworth and Co., Ltd., Walker.—All motors are of the three-phase induction type, supplied at 440 volts. The winches are of MacTaggart Scott's and Clarke Chapman's make. There are motors driving all classes of shipbuilding machines, including heavy plate-rolling plant. The lighting is given by direct-current enclosed 5-amp. arcs, two in series across 240 volts.

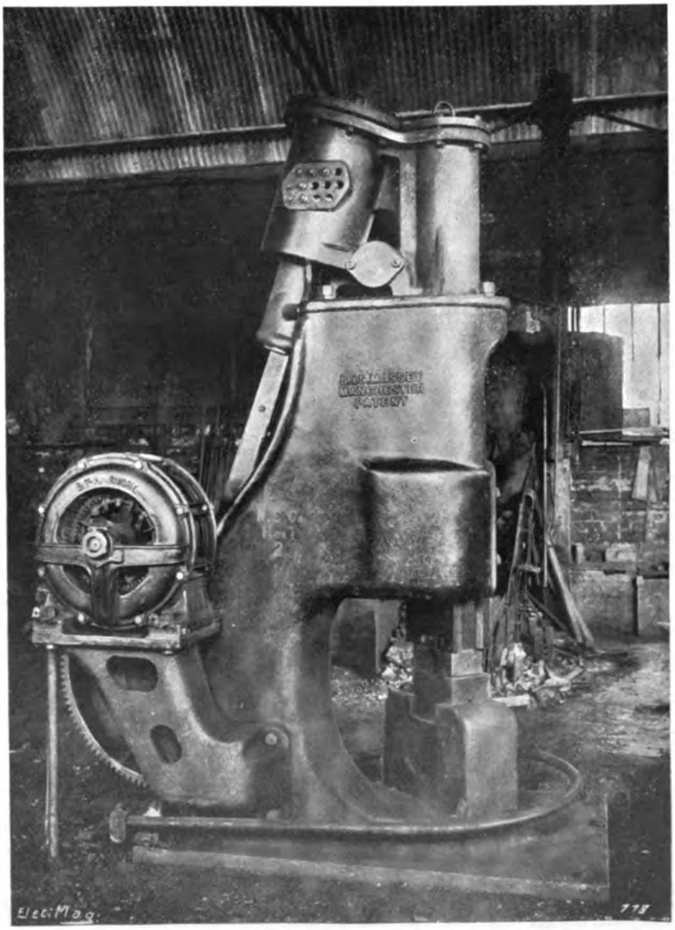
Wallsend Slipway Co.—All motors are of three-phase induction type, supplied at 440 volts, with the exception of cranes, which are all direct current, supplied by various makers. The motors are practically all of the short-circuited rotor type, driving line shafting for the machine tools. In the boiler-shop there is a heavy plate-rolling plant driven by a 50 h.p. variable speed motor.

Lighting, all direct current at 240 volts.

Other Factories.—In addition to these the company supplies a number of other factories and has entered into a contract for the supply of a very considerable horse-power to the Elswick works of Sir W. G. Armstrong, Whitworth and Company, the shipyard of this firm at Walker being already supplied by the company.

North Eastern Railway.—In addition to the electrification of the railway itself, referred to later, the railway now obtains a large amount of power for the purpose of lighting and driving its stations, locomotive works, &c., in the district. There are already in use, or shortly to be put in use, 1,000 arc lamps, 20,000 incandescent lamps, and 100 motors—aggregating over 2,000 h.p.—in connection with this scheme.

Bulk Supply.—A contract has been entered into for supplying energy in bulk to the County of Durham Electric Power Supply Company, and at the present the



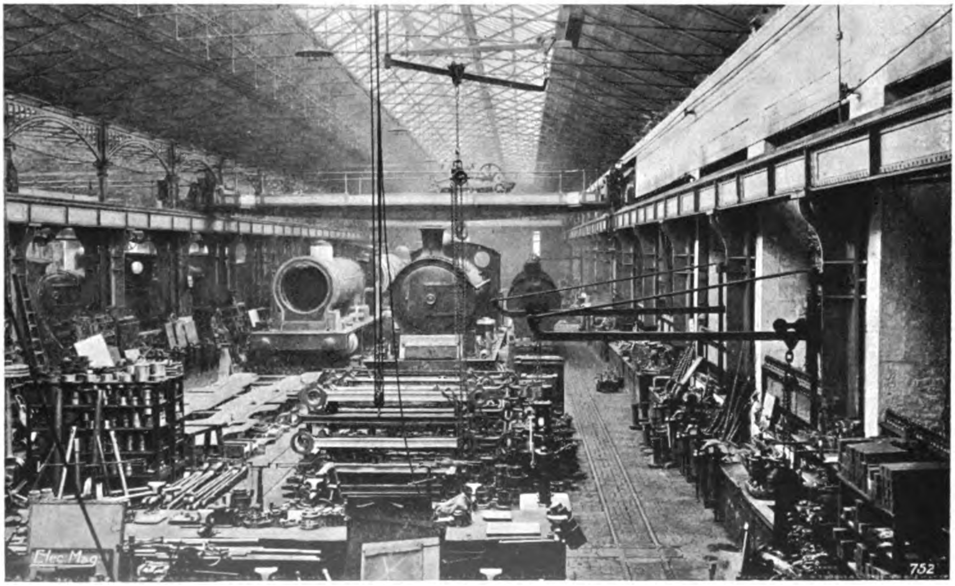
POWER HAMMER DRIVEN BY THREE-PHASE MOTOR

plant installed is approximately 2,000 h.p., the annual consumption last year being over 1,000,000 units.

Traction.

The Tyneside Tramways and Tramroads Co., Ltd.—The Tyneside Tramway Company's system is operated under the Tyneside Tramways and Tramroads Acts of 1901, 1902, and 1904. The cars provide communication between North Shields and Gosforth *via* Willington Quay and Wallsend. At two points, namely, Wallsend and Gosforth, the company's system is closely adjacent to that of the Newcastle Corporation, with whom mutual through-running has recently been arranged. At North Shields the Tynemouth and District Tramways system is within a few yards of the terminus. The district between North Shields and Wallsend is entirely industrial, the population being in the neighbourhood of 50,000. Gosforth is a residential suburb of Newcastle with some 11,000 inhabitants.

The company commenced operation in September 1902, and since this date the traffic receipts have shown a steady increase. The tramway track consists of about five and a half miles of single track and three and a half miles of double track, all equipped electrically on the overhead trolley system. The gauge is 4′ 8½″. The track between Wallsend and Gosforth—three and a half miles in length—is across more or less open country; it is accordingly of sleeper construction, with rails 77 lbs. per yard. The tramway rails in Wallsend and Willington Quay are 95 lbs. per yard. At present the rolling stock consists of six double-truck double-deck cars, and eighteen single-truck double-deck cars, accommodation being provided for eighty-five passengers on the large cars and fifty-nine on the smaller. The cars are fitted with Newell (Westinghouse) magnetic slipper brakes and ordinary hand brakes. The number of passengers carried during the six months ending June 30, 1904, was 1,461,971.



North Eastern Railway Locomotive Shops.

North Eastern Railway.—One of the most recent and important customers of the company is the North Eastern Railway Company, who obtain the whole of the energy for working their recently electrified system, some forty miles of double line, from this source.

Space does not permit of this scheme being described at length, but upwards of 15,000 h.p. will be ultimately supplied for this purpose.

Consumers' Department.

The rapid development of the company's business since the supply of power was first taken up is due to various causes, not the least being the conservative financial policy adopted by the directors. None of the issues of capital have been underwritten, and out of the premiums obtained the cost of the original installation, amounting to over £100,000, has been written off. The general policy, on the other hand, has been very progressive. Those responsible for the management early realised that in order to obtain customers, and more especially power users, something more was required than to offer a cheap power supply, and an energetic policy of canvassing and advertising has been adopted.

The means in use for pushing business consist of:

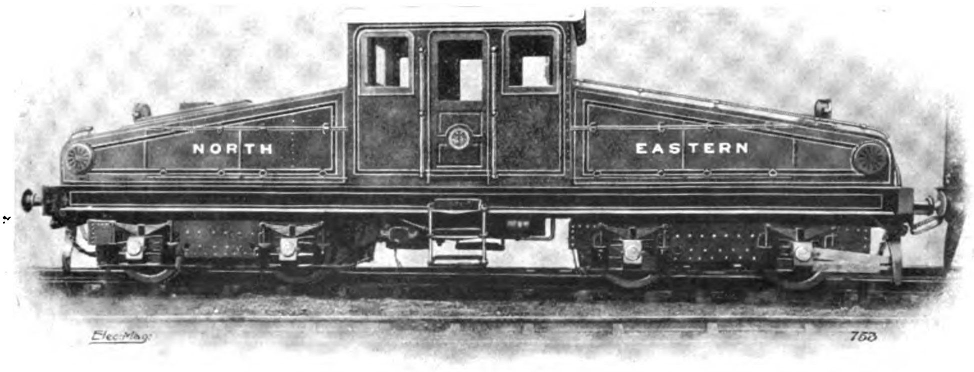
(*a*) Advertisement by pamphlet and the issue of a monthly periodical, which deals in a popular manner with subjects of interest to consumers.

(*b*) Personal canvassing and interviews with prospective customers and advising upon installations.

(*c*) A system of hire purchase for motor installations of any size. In some cases apparatus costing several thousands of pounds is installed and kept in repair by the company in return for an annual rental. This arrangement has many advantages, not the least resulting from the low price at which the company can buy apparatus.

The department keeps in close touch with builders and prospective tenants, both of new and existing buildings. The majority of the shop lighting is already electric and attention is now being specially directed to private houses.

The tariff charged to lighting consumers is on the maximum demand system, being 4½*d.* for the first 250 hours per quarter in winter and 125 hours per quarter in the summer quarters, all further units being charged at the rate of 1*d.* per unit.



North Eastern Electric Goods Locomotive.

There is a free wiring system in force, but it is found that most lighting consumers prefer to wire their own premises. Slot meters are being tried for cottage property, the tariff, including free wiring, being 5½*d.* per unit. The average prices obtained from various classes of customers are: slot meter consumers, 5½*d.*; ordinary lighting consumers, 3½*d.*; small motors, 1½*d.*; tramways, 1¼*d.*; manufacturers' installations, 1*d.* The prices charged to the latter depend upon the length of contract, nature of current, and other factors.

Conclusion.

In the introduction, allusion was made to the ideal arrangement of power supply

and the advantages to the community at large of obtaining energy from large interconnected systems. The details given of the scheme upon Tyneside show to what a considerable extent this has been carried out in that district. But a glance at the attached map shows that only a very small part of the company's area has as yet been dealt with. The requirements of the collieries, railways, and other power users in the neighbouring districts is very large, and will enable the company to extend its field of operations for many years to come.

The success obtained by the company in the past proves the truth of the principles set forth in the introduction, and foreshadows the time when the whole of the power requirements of the industrial area in the counties of Northumberland and Durham will be supplied from one large interconnected system. The benefits which the district will obtain from such a scheme should stimulate all power users to co-operate in the attainment of this result.

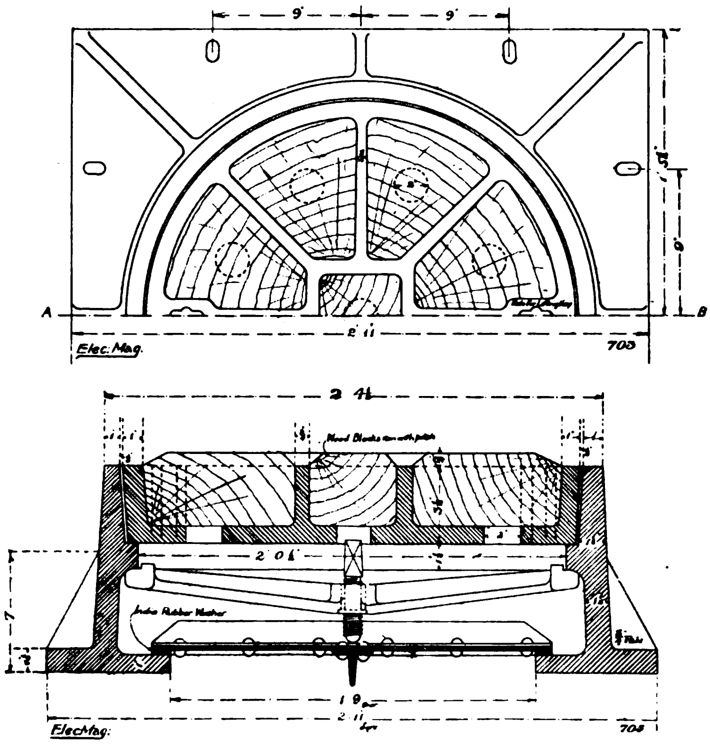
LONDON POST OFFICE TELEPHONE SYSTEM.

By W. NOBLE, A.I.E.E.

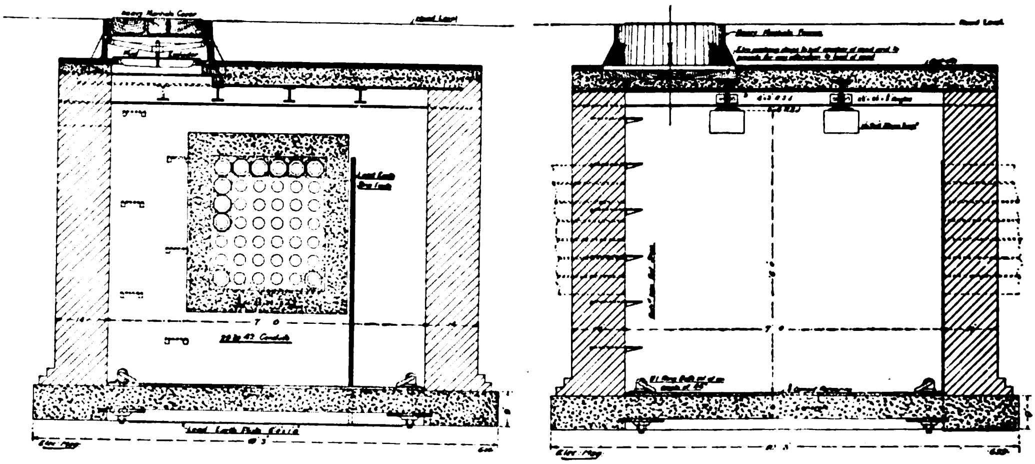
(*Continued from page* 120.)

MANHOLES. — Jointing chambers, or, as they are commonly termed, manholes, are, under normal conditions, built in each line of conduits at intervals of from 150 to 180 yards, the limiting factor being the length of main cable that it is possible to draw in. The interval may, in special cases, on straight routes, be increased to 200 yards; but on tortuous routes, or where there are obstructions in the ground, it is reduced. A manhole is generally built at street-junctions to facilitate the work of distribution along the streets branching off the main thoroughfares, in which, of course, the conduits are generally laid. Manholes are of two classes, footway and roadway. The footway manhole, known as the B type, is of nine-inch brickwork, with York stone roof on steel joists, and has an entrance consisting of a light cast-iron frame and cover, the cover being filled in with a composite stone.

Of roadway manholes there are two types, A and C. They are of fourteen-inch brickwork, the roof of the A type being of $\frac{3}{8}$-inch steel troughing, that of the C type of half-inch steel plate. In all other respects the A and C types are identical. Rolled steel joists support the roof. The entrance consists of a heavy cast-iron frame twelve inches deep. The cover-frame is of similar material, and has a central and eight segmental spaces filled with blocks of Jarrah wood set in pitch. Placed in the frame is a cast-iron plate, known as a mud-excluder, the object of which is to prevent not only mud, but, as far as possible, water, from entering the manhole. A special device is employed for clamping down the mud-excluder and a flat india-rubber washer assists in making a tight joint. Fig. 10 shows a half-plan, and Fig. 11 a section of the frame and cover, with details of the mud-excluder. Figs. 12 and 13 illustrate one of the standard jointing-chambers of the C type. As the drawings are mostly self-explanatory, further reference need only be made to one or two special points. In wet situations the walls and foundations are waterproofed with a $\frac{3}{4}$-in. coating of asphalte. For the prevention of electrolytic damage to the lead sheathing of the cables, an earth-plate 6 ft. by 1 ft., of 5-lb. sheet-lead, is laid under the concrete foundation, and from



FIGS. 10 AND 11. HALF-PLAN AND SECTION OF MANHOLE FRAME, COVER, AND MUD EXCLUDER.



FIGS. 12-13. SIDE AND END VIEWS OF STANDARD C TYPE JOINTING CHAMBERS.

this plate a one-inch strip of similar lead is carried to the top tier of conduits, being eventually soldered to the sheath of each cable in the manhole. Embedded in the concrete foundation in each corner of a manhole is a wrought-iron ring-bolt, with a cast-iron foundation plate, to form an anchorage for the tackle used in pulling in cables.

In the London system any number of cables from six to ninety may pass through a manhole, which may in addition contain one or more cable distribution heads, whence a large number of small, or distribution, cables radiate to the footways. Obviously, then, sizes vary. The following are a few of the standard sizes :

Type.	Inside Dimensions. Length.	Width.	Depth.	No. of Ducts entering Manhole
Roadway :				
A^1 or C^1	8 ft. 0 in.	4 ft. 0 in.	4 ft. to 6 ft.	12 to 24
A^2 „ C^2	8 ft. 0 in.	5 ft. 6 in.	4 ft. „ 6 ft.	24 „ 36
A^3 „ C^3	8 ft. 0 in.	7 ft. 0 in.	5 ft „ 6 ft.	36 „ 54
A^7 „ C^7	5 ft. 9 in.	4 ft. 0 in.	4 ft. „ 6 ft.	3 „ 12
A or C-Special	..	..	..	above 54
Footway :				
B^1	8 ft. 0 in.	4 ft. 0 in.	4 ft. to 6 ft.	12 to 24
B^2	8 ft. 0 in.	5 ft. 6 in.	5 ft. „ 6 ft.	24 „ 36
B^3	4 ft. 0 in.	4 ft. 0 in.	4 ft. „ 6 ft.	3 „ 6
B^5	6 ft. 0 in.	4 ft. 0 in.	4 ft. „ 6 ft.	3 „ 12
B-Special	..	..	..	above 36

Manhole-to-Footway Connections.—Every manhole is connected to the adjoining footways by three cast-iron pipes, four-h pipes being employed in Central London and three-inch in the outer area. These pipes terminate in a footway jointing-chamber known as a double-junction box. Fig. 14 is a plan of a typical manhole-to-footway connection.

Footway Joint-boxes.—For distribution purposes footway joint-boxes are used. The following are their designations and sizes :

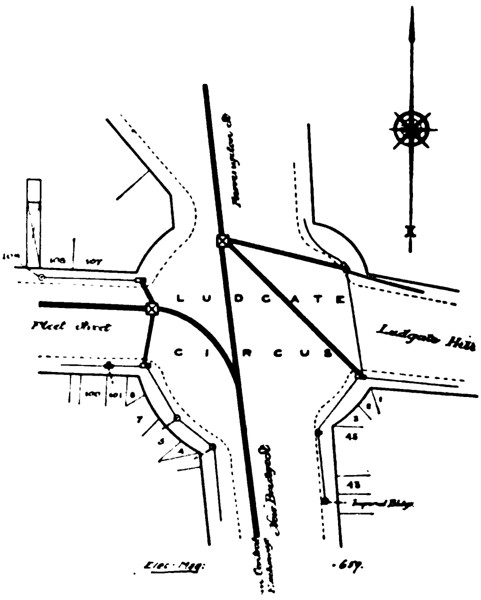


FIG. 14. PLAN OF TYPICAL MANHOLE TO FOOTWAY CONNECTIONS.

Designation.	Internal Dimensions.	
	Length.	Width.
Double junction	4 ft. 2 in.	1 ft. 11 in.
Single junction	1 ft. 11 in.	1 ft. 11 in.
Extra large	2 ft. 11 in.	1 ft. 5 in.
Large	2 ft. 10 in.	1 ft. 2 in.
Small	2 ft. 4 in.	9½ in.
Distribution	1 ft. 2 in.	8 in.

The depth of these boxes varies with the depth of the pipes entering them, and this depends largely on the obstructions under the footway. The size of joint-box selected is governed by the number of pipes and cables that it is to accommodate. A plan and a sectional elevation of a double-junction box are shown in a later portion of this article.

Cables.—The main cables used in the telephoning of London are of the air-space type, with paper insulation and lead sheath, or, as they are commonly termed by the Post Office, paper-core cables. For subscribers' lines the conductors are of No. 20 standard gauge, weigh 20 lbs. per mile, and have a resistance of 43.89 ohms. For junction lines, connecting Post Office exchanges, the wires are of No. 18 gauge, weigh 40 lbs. per mile, and have a resistance of 21.94 ohms per mile. The largest cable for subscribers' circuits has an external diameter of 2.75 in. and contains 306 pairs of wires. Such a cable is mostly employed in Central London, smaller cables being used in subsidiary areas.

Junction cables have an external diameter of 2.85 in. and contain 108 pairs of wires. The cables are tested at the manufacturers' works for insulation resistance and electrostatic capacity. With a battery of not less than 300 volts the insulation of any cable must be not less than 5,000 megohms. The electrostatic capacity is .08 microfarad for cables containing not more than 358 wires and from .085 to .095 for cables containing a larger number.

On the completion of the laying of a cable, it is subjected to an air-pressure test, being filled with dry air up to a pressure of 24 lbs. indicated by gauges inserted in a nozzle at each end. After twenty-four hours the pressure must not have fallen more than 1 per cent. This is a searching test of the plumbers' wiped joints.

Cabling.—The operation of cabling is too well known to telephone engineers to call for description here. One special feature, however, to which reference must be made is the form of cable-grip, known in the Post Office as the Wire Grip. It is simple in principle and is illustrated in Fig. 15, which shows the grip in position on the end of a cable. It is a distinct improvement on all other forms, but as its efficiency depends on the preparation of the cable-end to receive it, a description of the process of preparing the cable-end will not be out of place here. The manufacturer's sealing-disc is cut off the end, the conductors are driven down inside the lead sheath for about an inch, the sheath is beaten over the end by means of a boxwood dresser until the opening is only about an inch in diameter, when a lead disc is inserted and the sheath is dressed hard down on the disc. The small recess remaining is then filled with solder by means of a copper bit. For a distance of about two feet from the end the cable is constricted and the air-space greatly diminished, the sheath being compressed by the boxwood dresser on to the copper conductors, practically a solid mass

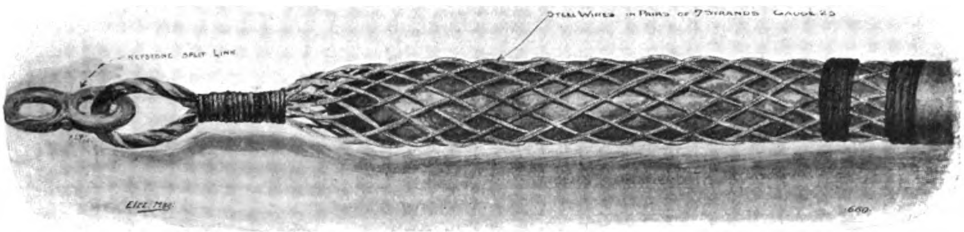


Fig. 15.—Wire Grip Fixed on a Cable End.

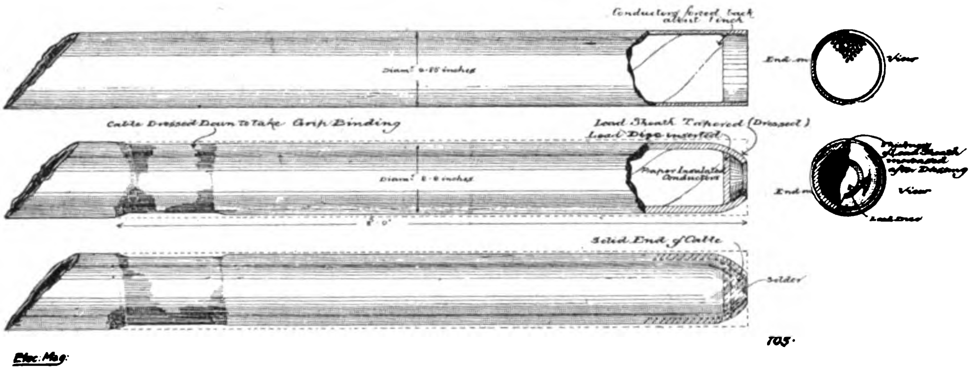


FIG. 16. METHOD OF PREPARING CABLE END FOR WIRE GRIP.

being thus formed. By this process the diameter of a large cable is reduced by about a quarter of an inch and the thickness of the lead sheath for the two feet is increased. At about twenty inches from the end the sheath is further compressed, a slight indentation being made for a distance of about two inches, to enable the end of the wire-grip to be tied with stout tape, as a precaution against the grip slipping when the tension is first applied. The over-all diameter of the cable at the end with the grip in position is not increased, and the grip, being flexible, bends to suit any curvature in the conduit line. Fig. 16 illustrates the method of preparing a cable-end for the wire-grip.

In Germany, Belgium, and other Continental countries, where this form of grip is largely used, the cable end is prepared at the works of the cable manufacturers by means of special machinery; but the British Post Office practice of preparing the end where the cable is to be drawn in entails no loss of time, as, while this work is being done by two men in the cabling gang, the others are engaged in cleaning out the conduit by means of a special brush, and passing a three-feet "test" piece of cable through the conduit. It having been found that the grip wears out more rapidly at its nose than elsewhere, a stout raw-hide shield about three inches long is under trial and premises to effect considerable economy in the life of the grip.

In the process of drawing in a main cable, blocks and ropes are used in the manhole, the tackle being made fast to the ring-bolts fixed in each corner of the manhole. The arrangement most generally in use is that of fixing a snatch-block in a direct line with the conduit into which the cable is being drawn, the pulling-rope passing from the conduit through the snatch-block and up the manhole entrance vertically to the crab-winch placed over the manhole. After the cable has been drawn in as far as the tackle will admit, there is usually about 4ft. 6 in. of cable in the manhole. For a straight-through joint this length is generally sufficient, but for cable-head work it is necessary to have a greater length of cable in the manhole. To achieve this object it has hitherto been the practice after detaching the wire-grip to employ a method known in nautical parlance as "racking." This is illustrated

FIG. 17. METHOD OF "RACKING" A CABLE.

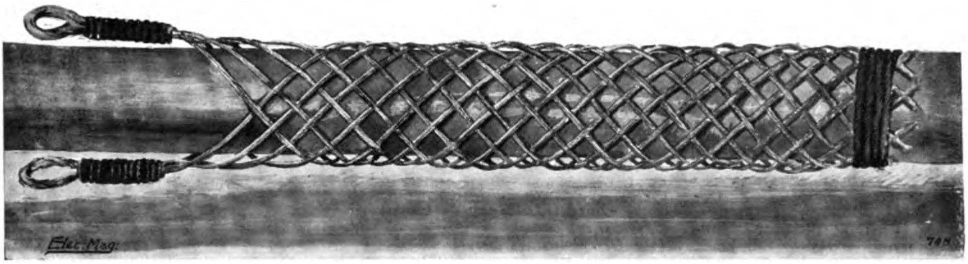


Fig. 18. Special Wire Grip to replace "Racking" Method.

in Fig. 17. The pulling-rope and cable are bound together by soft yarn from a point near the mouth of the conduit for a distance of two feet, the yarn being passed around the cable and the rope in the form of the figure 8. This method was also employed in pulling out of a conduit a cable to be replaced by a larger one. While serving its purpose admirably, the "racking" process was slow and expensive. It is now superseded by a special wire grip with open ends, one end being finished off as in the case of the ordinary grip and the other with two eyes. Fig. 18 illustrates its application. It effects economy in time and labour, especially in the drawing out of complete lengths of cable. By means of petroleum jelly all cables are thoroughly lubricated as they pass into the conduits.

Jointing.—As in cabling, so in jointing, the process varies so little from general practice as to need no description here, and reference will be made only to one or two special features in the British Post Office work. In every lead sleeve covering a joint, a nozzle with screwed cap is inserted. The object is to admit of the plumbers' wiped joints being tested by air-pressure and to provide afterwards an inlet or outlet for dry air when a desiccator is applied to the cable. After a cable has been completed throughout its length and tested, a small tinned-copper disc is soldered over the orifice of the nozzle to ensure the exclusion of damp from the cable in the event of a cap becoming loose.

"Terminating" pipes are used in small manholes and in footway boxes where a main cable has to be jointed. These are made either to suit a duct, or a 3-inch or $\frac{3}{4}$-inch pipe. They are of sufficient diameter to admit of the lead sleeve being pushed back while a joint is being made. This arrangement avoids the use of a split sleeve with its objectionable longitudinal wiped joint.

On the completion of each joint the plumber's work is tested by means of a portable desiccator, described later. The wiped joints having been smeared over with soap-suds, air is forced in at the nozzle in the sleeve and the slightest flaw in the work is thus at once detected by the formation of bubbles.

Cable Distribution Head.—Subscribers' main cables in all cases terminate in a cable distribution head, the object of which is to provide a means of dividing up the large cables into smaller cables to serve subscribers. Fig. 19 shows a longitudinal elevation and a plan of a head. It is an octagonal-shaped cast-iron box having in each of six faces (the ends and the four adjoining sides) a round hole drilled to admit of cables being passed in.

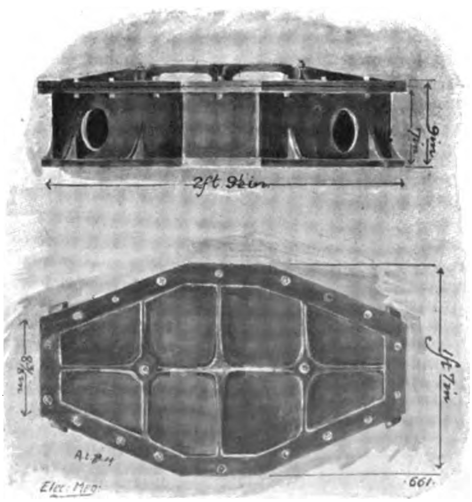


Fig. 19. Cable Distribution Head—Longitudinal Elevation and Plan.

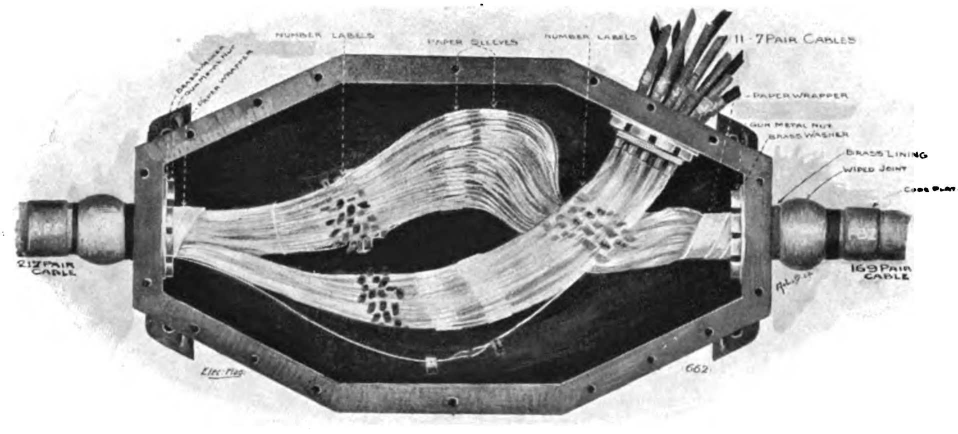


FIG. 20. CABLE DISTRIBUTION HEAD—INTERNAL CONNECTIONS.

The upper edges are flanged to take a cover which is bolted down to the frame, a washer consisting of two layers of oiled paper being used to make the joint sound. To assist in rendering the chamber air-tight, the upper surface of the flange and the opposing surface of the cover are carefully planed, as also are the edges of the six holes. For carrying the main cables through the holes into the cable distribution head gun-metal linings are employed, having an inner end of fixed diameter to fit into the head, but an outer end of varying diameter to suit the different sizes of cables to be brought in. They are fitted inside with a brass washer. a dressed-leather washer being used on the outside to secure an air-tight joint. The lining is secured by means of a screwed nut slotted round its edges. a pin-spanner being used for the purpose of screwing home the nut.

The cable distribution head is secured to the walls of the manhole by Lewis bolts passing through a hard-wood plug, a clear space of about three-quarters of an inch being maintained between the wall and the back of the box. It is generally fixed with its greater length in the direction of the line of conduits, the main cable from the exchange entering by the lining in the end-hole nearer the exchange, the opposite end-hole being used for carrying a smaller main cable to the next manhole when all the wires in a 306-pair cable are not required at one point. The ends of the linings in which main cables are fixed are tinned, the cables being wiped on by means of a plumber's joint. The wires likely to be required for subscribers to be served from a given manhole are taken out of the cable distribution head by means of seven-pair cables. Linings similar to those described above, but fitted with eleven seven-pair cables, are generally fixed in the side-holes of the head, any openings not required for cables being blanked up with a cast-iron plug fitted by means of brass and leather washers exactly in the manner of the linings. On the outside end of these seven-pair linings is a two-foot length of cable and on the inside end an eighteen-inch length. Fig. 20 shows the internal connections in a cable distribution head.

In order that it may be readily ascertainable whether a cable-head is sound, and to provide for its future desiccation, there are two holes in the cover fitted with $\frac{3}{4}$-inch gas-plugs. These are removed when drying a cable-head, one hole taking the hose-pipe from the desiccator, the other allowing the air to escape. When dry air is being pumped through a cable from the exchange desiccator, only one plug is removed. On each occasion of a cable distribution head being opened, it is desiccated for a period governed by the time it has been opened and the state of the atmosphere. The castings of cable distribution heads are received from the foundry in the rough, being planed, drilled, and proved by air-pressure by the Post Office before being issued. Three sizes of cable

distribution head are employed, the particulars of which are as follows :

Description.	External Dimensions.			Size of Cable.
	Length.	Width.	Depth.	
Extra large	2 ft. 9½ in.	1 ft. 7 in.	7 in.	217 to 306 pairs
Large . .	2 ft. 3½ in.	1 ft. 5½ in.	8½ in.	137 „ 217 „
Small . .	1 ft. 7½ in.	1 ft. 1½ in.	8½ in.	37 „ 108 „

When the seven-pair cables are taken through the solder in a lining, the solder has a tendency to make the lead sheath brittle, and if the cables were bent at this point, the sheath might crack. To prevent the bending of the seven-pair cables at their weak point each lining is issued with a bored wooden disc, which is threaded over the cables and fixed in position as shown in Fig. 20. As a further precaution the cables are tied with prepared tape, and when a lining is fixed in position in a cable head the cables are tightly bound with tape from the wooden discs outwards for about six inches.

Portable Desiccator.—In addition to the large stationary desiccator installed in each exchange, the Post Office, at the outset of the London work, designed a compact and convenient form of portable desiccator and pump, for testing plumbers' wiped joints, for proving that cable dis-

FIG. 21. VIEW OF PORTABLE DESICCATOR CONNECTED TO CABLE.

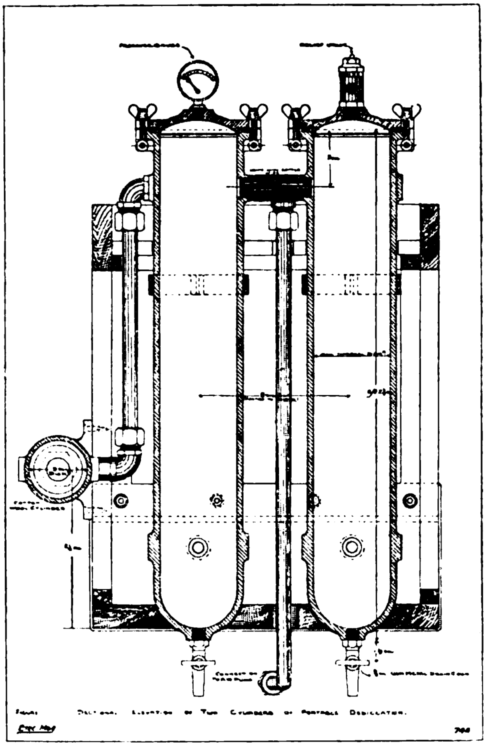


FIG. 22. PORTABLE DESICCATOR—SECTIONAL ELEVATION OF TWO CYLINDERS.

tribution heads are air-tight, for desiccating the latter on the completion of the work carried out in them, for desiccating a detached portion of cable, and for expediting the drying of a cable extending for a considerable distance from the exchange. The portable desiccator has proved eminently satisfactory, and is a valuable adjunct in paper-core cable work. It is shown complete in Fig. 21. It consists of four cast-iron cylinders, 2 ft. 2⅞ in. long and 4 in. in diameter, fitted vertically, and one cylinder 1 ft. 4 in. long by 3 in. fixed horizontally and connected to the fourth vertical cylinder by means of three-quarter-inch copper tube, the first vertical cylinder being connected to the pump by a similar tube. Of the vertical cylinders the first is fitted with a relief-valve and the fourth with a pressure-gauge. All four are filled with calcium chloride held in a bag made of cheese-cloth, suspended from the top of each cylinder by an ebonite bar, and each has a slotted cover secured by bolts, and at

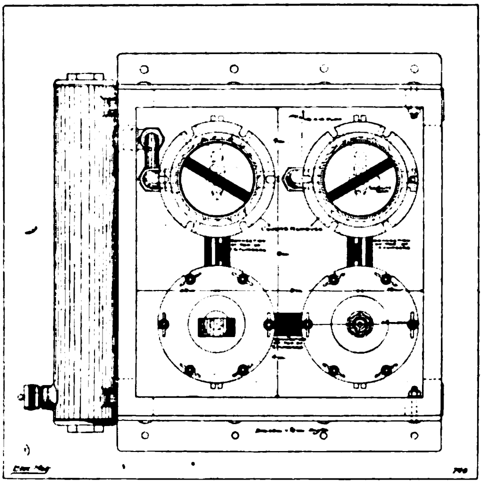


FIG. 23. PORTABLE DESICCATOR—PLAN.

the bottom a tap for draining off water, extracted from the air as it passes through the calcium. The horizontal cylinder is lightly packed with medicated wool and is closed by a screwed cap.

Fig. 22 shows a sectional elevation of the first and fourth vertical cylinders, and Fig. 23 a plan of the five cylinders. A three-cylinder pump is used. Both pump and desiccator are mounted on a small handcart, the total weight being about 6½ cwt. To connect a desiccator to a cable ¾-inch india-rubber hose is employed with a union at each end. The calcium chloride is renewed according to the amount of work done and the condition of the atmosphere from which the air is drawn. An indication of the state of the calcium is obtained by noting the amount of water drained off the first vertical cylinder. When a desiccator is in constant use one cylinder is replenished on an average each day. This is done by recharging the fourth cylinder, bringing forward the calcium from the fourth to the third, and so on, that in the first being thrown away.

W. Noble

(*To be concluded.*)

Readers are referred to the World's Electrical Literature Section at the end of the Magazine for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

A Note on Gas-driven Power Stations.

By W. E. WARRILOW, A.M.I.E.E.

We are living in constant hope that the gas-engine will assert its superiority over its steam rivals for power generating purposes in a manner leaving no doubt in the mind as to the soundness of its claims to pre-eminence. On the one hand so much is heard of what the gas-engine is going to do, and on the other of what it has failed to do—as instanced in its displacement by steam in several stations—that until some really striking move is made little but discord can ensue among the partisans of this form of power-plant.

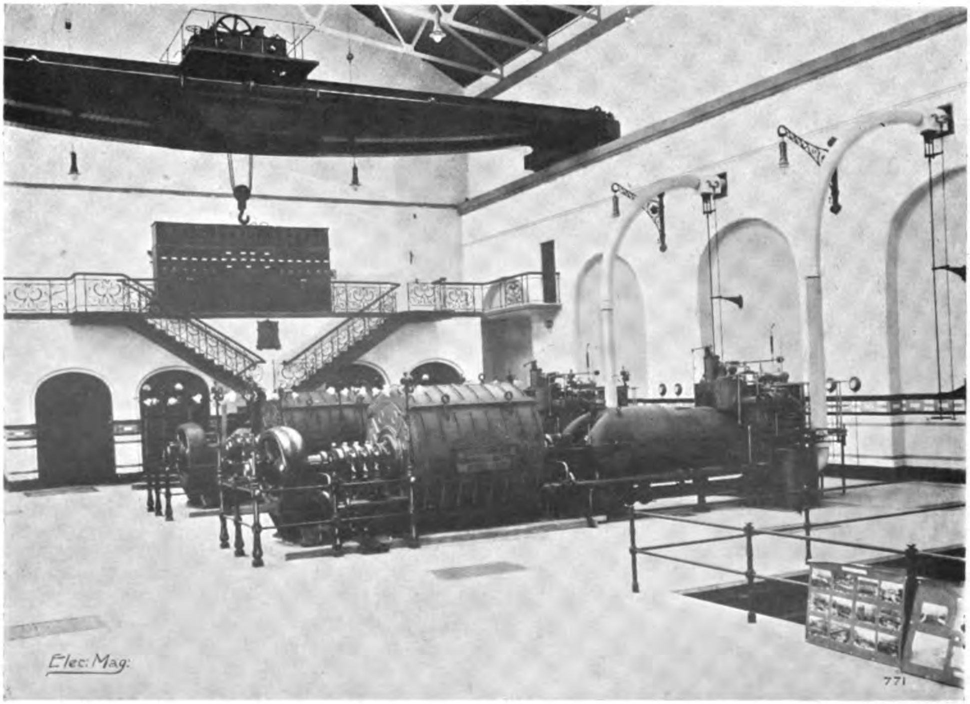
In spite of its past failings the gas-engine has been slowly but surely improving. Active workers in this sphere are sanguine of its future, and with no small measure of success to encourage, they are making steady progress. Still the records of gas-driven power-plants of any size are but few, and despite the glowing accounts of its possibilities now everywhere heard, when these take practical shape we might say that "the mountain hath given birth to a mouse." The plants installed are niggardly in output to the extreme, so much so that they hardly establish anything in support of the great "case" they seemingly represent. We need hardly remind our readers of the numerous failures of gas-plant installed for public lighting and power purposes in this country and their subsequent displacement by steam—this only after months or years of patient effort to cope with the troubles constantly arising. They are striking instances of a laudable effort to exploit the gas-engine at an unfavourable epoch in its career, and of the reaction which followed as a natural consequence.

At the present time, however, it seems that the gas-engine makers are feeling their feet again, and after what has proved a stimulating experience with belt-driven dynamos, have taken serious steps towards perfecting the direct coupled unit. In this particular it seems almost deplorable that the experience of steam engineers, with the horizontal engine for driving dynamos, has not taught the same lesson to gas engineers, and hastened the appearance of the vertical gas-engine. The principle involved differs in no way with the gas than with the steam-engine, and only on grounds of a demand for the horizontal engine in other quarters, can its retention and exploitation for dynamo work be supported. It must be admitted that the gas engineer has an uphill task before him, but so far he has contented himself with his smaller trade, and either ignored or given but scant attention to work having a far wider scope and greater influence upon his particular branch of industry. Meanwhile the steam engineer has made the most of his opportunity, and perfecting the earliest machines at his disposal, through horizontal and vertical reciprocating unit to the simple rotary engine now being developed in a vertical form, he has widened considerably the gaps between himself and his gas rival, who remains far in the rear wrestling with those similar, though more pronounced, problems which he has successfully overcome. This may seem unfair criticism of the labours of gas engineers, but facts certainly point to distinct apathy on their part to create a demand for the large gas-engine. Discouraged by the competition of steam in the electrical world and supported

by a small trade which admits of no striking developments, the gas engineer is being led along a *cul de sac*, but judging by events he does not see this. The preference has so far been given to steam-plant and apart from the slow progress in gas-engine development, the tendency has been to spend money on the perfection of steam units. Circumstances generally have hampered rather than encouraged the use of large gas-engines, and seeing that the industry has committed itself so largely to the use of steam, the task before the gas engineer is an even more heavy one. Pledged as we now almost seem to steam on every hand, the task of introducing gas-engines will resolve itself probably into capturing the smaller stations, and trusting to the march of events to hasten the day of the large gas-engine and ultimately the gas turbine.

NEW TURBO STATION AT SHEFFIELD.

Sheffield can boast the oldest electric supply plant in the United Kingdom, and throughout its varied career the most sanguine of its pioneers would not have prophesied so marked a development as that evidenced in its latest station at Neepsend. Under the able management of Mr. S. E. Fedden, the undertaking has made remarkable progress and despite the variety of plant supplying Sheffield with light and power, the scheme promises well for the future. Many of our readers will recollect the early experiments in parallel running made at Sheffield when Mordey and Ferranti alternators were first switched in step, and the first successful single-phase plant set going. The history of the plant since then would make excellent reading, but we content ourselves at present with a bare reference to the chief features of the plant. Two Stirling water-tube boilers with Bennis quadruple machine stokers working under induced draught furnish the requisite steam to two 1,500 k.w. Parson's turbines designed for 150° superheated steam. These machines, which are of the latest type run at 1,500 r.p.m. and are connected by flexible couplings to two-phase alternators of the output mentioned above. These supply current at 2,200 volts 50 cycles to the net-work through a B.T.H. switchboard fixed on a high gallery at the end of the engine-room. The complete plant can be gathered from the adjoining illustration. A battery, to be provided, will furnish current for the station lighting in case of break-down. Variable boosters comprising transformers with multi-contact switches enable the



INTERIOR OF NEEPSEND POWER-HOUSE, SHEFFIELD.

feeder pressure to be kept constant at the feeder ends in the city. The old single-phase net-work remains unaltered except in changes necessitated in arc lamps, meters, and some transformers, by the change of frequency. A striking comparison is afforded between this plant and that of the old Commercial Street Works where machinery representing almost every epoch in dynamo electric machinery and prime movers has been installed. Our thanks are due to Mr. Fedden for his kindness in supplying the photograph from which our illustration is taken.

A MEXICAN HYDRO-ELECTRIC PROJECT.

An important hydro-electric power scheme has recently been put into operation in the States of Michoacan and Guanajuato. Mexico. The accompanying map (Fig. 1) indicates the system and country included by it. The installation embodies many features which are distinct departures from current practice. The water supply is taken from the Duero River. and careful calculations indicated that a power-plant of 8,000 h.p. might be kept constantly in use. Fig. 2 is a plan of the river, canal, and pipe-line. The canal, which taps the river and feeds the pipe-line, is 2,220 yards long, and has a carrying capacity of 283 cubic feet per second, at a velocity of two to three feet per second. A "rating flume" is provided for measuring accurately the volume of water allowed under the concession. A settling section is provided to collect sand which can be drawn off by special valves fitted for the purpose. The pipe-line is 3,300 ft. long, and without lateral bends. The sections were riveted by hand by a gang of expert boiler makers sent to Mexico for the purpose. Two riveters, a helper and forgeman could complete one circular seam per day. The rivets were passed in through a hole drilled in the top side of the pipe, afterwards plugged with a screw plug. The pipe was not, as commonly, supported on piers above ground, but laid in a specially prepared trench. The line was tested on August 24,

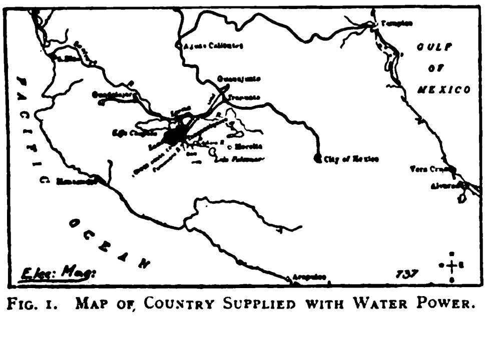


FIG. 1. MAP OF COUNTRY SUPPLIED WITH WATER POWER.

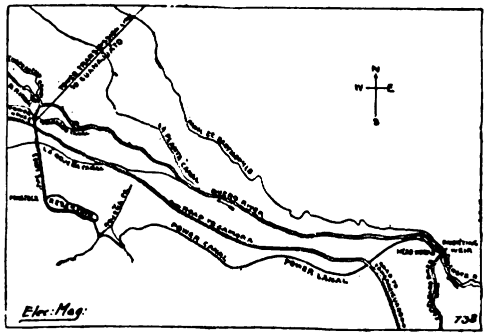


FIG. 2. PLAN OF THE RIVER DUERO, CANAL AND PIPE-LINE.

1903, and though 70,000 rivets had been put in not a single leak was discovered. The line terminates in a CI branch piece leading to the nozzles in the power-house. The nozzles have removable tips and needle regulating valves, together with a deflecting hood for governing the speed (Fig. 3). The water emerges from the nozzle tips in jets more than 6 inches in diameter at a velocity of about 1½ miles per minute, and a pressure of 138 lbs. per square inch. It impinges on the buckets of the water wheel, there being fifteen buckets 2 ft. wide and weighing 254 lbs. each. The wheels, of which there are two, one on each side of the generator, are overhung from the bearings, there being only two of these. The generators are 1,250 kw. 3-phase 60 cycle 2,300 volt machines running normally at 200 r.p.m. and designed to give 25 per cent. overload continuously. Exciting current is furnished by two 120 kw. units driven by separate water wheels. The generator pressure is raised to 60,000 volts by 1,800 kw. static transformers.

The transmission line, 101 miles long, differs materially from American practice in several ways. The conductors are stranded instead of solid, the supporting media are steel towers and not wood poles, and the spans are unusually long. The towers are forty feet high, made up of four galvanised steel posts braced and stayed with smaller rods. Twelve towers per mile is the average distance, being 440 ft. between each. Near Guanajuato a few 60 ft. towers were needed and spans up to 1,320 ft. in length. The insulators are 12 in. high, and 14 in. diameter, being built of four pieces and tested at 120,000 volts for five minutes before use. They are of porcelain with a brown glaze and weigh 15 lbs. The line is divided into four twenty-five mile sections. each in charge of a superintendent. At Guanajuato the line voltage is lowered to 15,000 volts, at which pressure it is distributed to the various consumers and reduced on their premises to 460 volts for motor service. The existing 2-phase supply station of that city

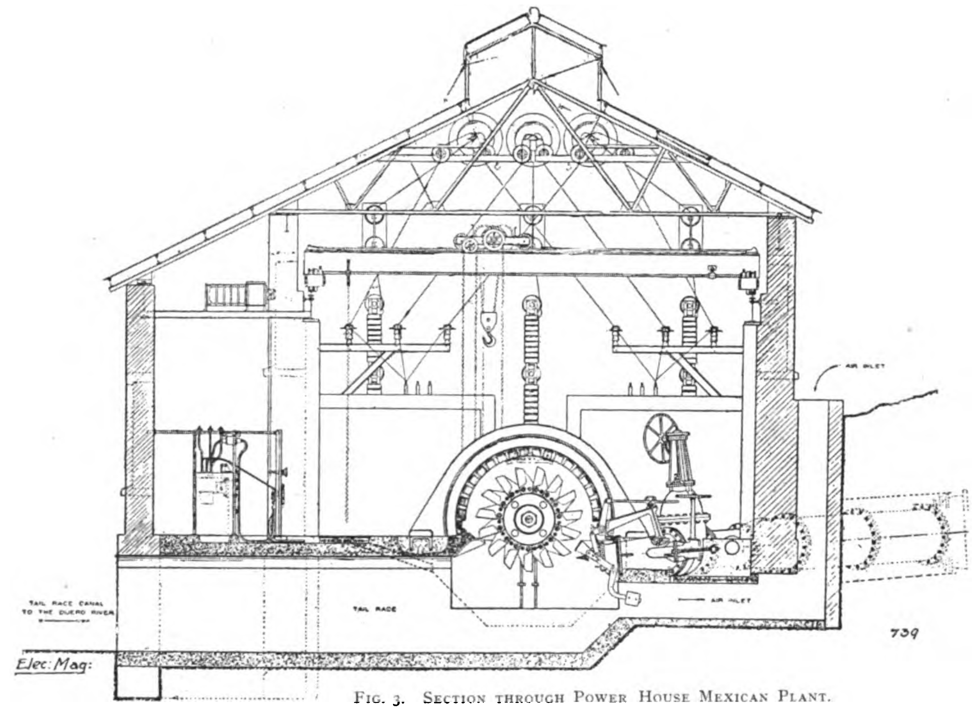
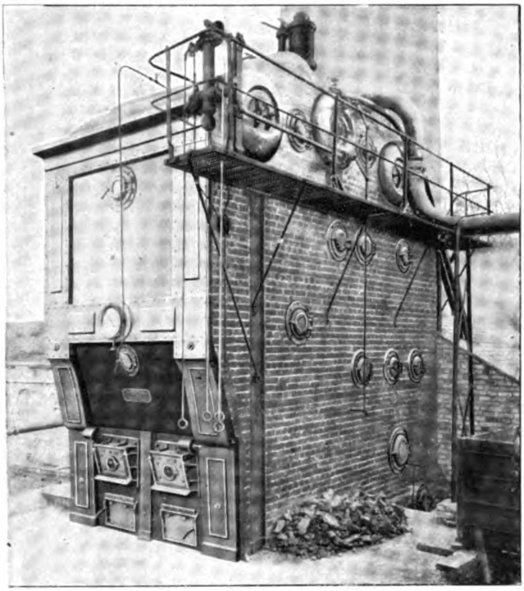


Fig. 3. Section through Power House Mexican Plant.

is connected up to 3-phase 2-phase transformers. A branch line also extends to Trapuato, the "strawberry station" on the Mexican Central railway. The entire undertaking is due to the enterprise of American engineers who have succeeded at last in harnessing the waters of the Duero. By the installation of this plant, the old silver-mines of Guanajuato, said to have produced one-fifth of the world's silver in 350 years, will be revived, and the inactivity occasioned by the high cost of power give place to a renewed development. Great difficulties were experienced in getting the plant to the power-house, as the roads were treacherous and only mule haulage available. Yet the time taken between the preliminary examination and the operation of the plant did not exceed eighteen months. This is a record for Mexico, especially having regard to the magnitude of the undertaking and its completion below the estimated cost.

STEAM FROM WASTE HEAT.

We hear constantly that the blast furnace gas-engine is likely to displace the steam-engine for purposes of electricity generation from what may be termed waste products. But there is still a field for the steam-engine judging by the results obtained with steam raising from waste heat from coke ovens. The Stirling Company, Manchester, have favoured us with some details of tests they have made with their boilers fired with waste heat, at Victoria Garesfield Colliery of Priestman Collieries, Ltd., Newcastle-on-Tyne. We must first before referring to these tests, endorse the company's remarks that the water-tube boiler is vastly superior to the Lancashire or Cornish types, for work of this character. A good average with either of the latter would show a mean of 1.2 lbs. of water evaporated per pound of coal coked while with a water tube this would be increased at least 25 per cent. and more often than not 35 per cent. The characteristics of a water-tube boiler are sufficient evidence in support of its superiority over the other two types. The boiler tested of which we give an illustration had a total heating surface of 1,611 square feet, and the trials were continued over four days, the total duration being thirty-two hours, and the mean pressure 131 lbs. The evaporation per pound of coal coked from and at 212° F. averaged 1.7 lbs., and per square foot of heating surface, 4.01 lbs. The number of ovens drawn was eight, some twenty-two were in use, and had they all been in use much better results would have ensued. The gases were admitted through an aperture in the bridge wall though an ordinary grate is fitted for hand firing. The mean temperature of the water was 165.4° F., and the gases entered the



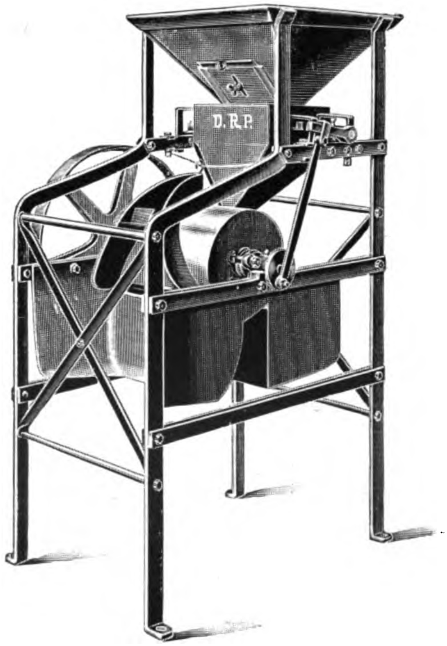
Stirling Boiler Fired from Waste Gases.

boiler at a mean temperature of 1,720° F., leaving at about 680° F. The boiler inlet is 29 ft. from the oven outlet so that there would be considerable radiation between ovens and boiler. The evaporation guaranteed per hour was 5,633 lbs from and at 212° F. and 1.42 lbs. of water per pound coal coked. The mean evaporation over four days was 6,465 lbs., and 1.7 lbs. of water, 14.8 per cent. and 20 per cent. in excess of the guaranteed quantities.

The possibilities of raising steam for electric power purposes in this manner are such as to enhance the prospects of the steam-engine for dynamo driving, especially in its latest turbine form. Now that the efficiency of the method is practically demonstrated we shall look for a wider utilisation of waste coke oven heat, and its application to electric power purposes. Meantime, we commend engineers interested in the question to study the Stirling Company's pamphlet.

SORTING METALS BY ELECTRICITY.

The electro-magnetic separation of metals is nothing new in the use of electricity, but the machine we illustrate possesses the special quality of sorting metals of all shapes and sizes which may be put into it. A strong magnetic field is produced in a bell-shaped magnet and the material to be sorted is brought close to this by the funnel to be seen in the cut. An oscillating cylinder running at about 15 r.p.m. below, loosens and distributes the material over the magnetic field. Special arrangements are made for removing the sorted material. The machine will work quite satisfactorily unattended, save for putting in fresh material. About 16 cwt. per hour can be dealt with, and at present the machine is built for direct current up to 220 volts, about 200 watts being consumed. The apparatus can be obtained from Messrs. Kuettner and Macdonell Adelphi, and we understand that it will operate quite successfully with any material containing iron.



Electro-magnetic Sorting Machine.

GENERAL POWER NOTES.

Water Power in Great Britain

A valuable paper, "Electricity from Water Power," was read before the British Association at its Annual meeting by Mr. A. A. Campbell Swinton. In this he drew attention to the fact that the first water power plant of any description was installed in Northumberland at Cragside, by the late Lord Armstrong in 1882, so that Great Britain can claim the credit for laying down the first hydro-electric transmission on a practical scale. Mention was made of the plants operated by water in this country, and also of several now in course of installation. The author pointed out that the generation of electric power by burning coal and raising steam was a matter of capital, whereas every water power plant installed was a permanent addition to human resources. A good dis-

cussion ensued in which Sir W. Preece referred to a project in the seventies to supply New York with hydro-electric power on which he reported, and had further shown that Niagara power could not be transmitted economically to a greater distance than thirty miles. Mr. McLellan pointed to the Scotch water power scheme which, when it reached Dumbarton, would directly compete with the Clyde Valley Power Co. who generated from steam and got coal at five shillings per ton. Mr. Campbell Swinton in replying said that adequate natural water power was not to hand in this country, and dams and reservoirs for impounding were prohibitive on grounds of expense.

Electrically Driven Cotton Mills.

At the fall of last year Mr. A. Kelly read a paper before the Manchester Insurance Institute on the electrical driving of cotton mills, and a reprinted copy of this was recently sent us. It contains some valuable statistics of American practice in this important branch of electrical work, and we consider it should be owned and kept for reference by every thinking mill-owner. After touching upon the chief methods of generating and distributing electrical energy, giving illustrated instances of operating plants, the value of the electric motor, in this special sphere is pointed out. The main arguments for the electric drive are carefully summarised at the end of the paper, and in this form make easy and valuable reading.

Electricity in Collieries.

Messrs. P. C. Pope and N. D. Cameron recently read a valuable paper before the Manchester Geological and Mining Society, in which some practical comparisons were drawn between the relative merits of direct and polyphase systems as used in British collieries. The paper is the more valuable in that it is based on British practice, a circumstance which enhances it as a work of reference for English colliery managers. The features of the two systems were carefully compared, and an instance taken from which it was considered that polyphase plant was 8 to 10 per cent. cheaper than continuous, and if the comparison be carried to plants operating at a considerable distance from the power-house, the advantages in favour of polyphase currents were still more marked.

Hydro Electric Power in Southern United States.

A power-plant has recently been completed on the Catawba River which possesses many unique features. Four 750-k.w. three-phase generators are installed, each *driven by ropes* from the water-wheels which are located directly below them. The rope speed is 4,780 ft. per. minute, and a weighted idler maintains the tension. The driving pulley is carefully protected from water. Each wheel unit comprises three 54-in. Hercules turbines of special pattern mounted on horizontal shafts and having a total capacity of 2,100 h.p. At present there are six such wheels installed. Power is distributed to various industrial centres, the longest line extending eighteen miles. The pressure is 11,500 volts. The plant was recently fully described in the *Electrical World and Engineer.*

Power Equipment of Mexican Railway Shop.

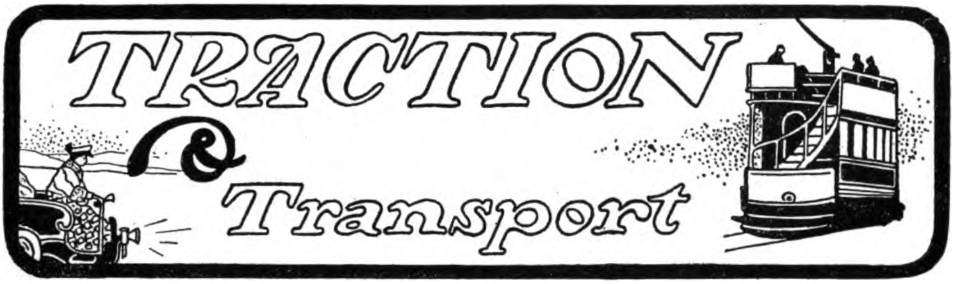
The Mexico City and San Louis Potosi shops of the Mexican Central Railway are the largest in Mexico, and have recently been remodelled and concentrated. A complete power-plant for electricity, steam, and compressed air distribution has been installed. The electrical plant comprises three De Laval 300-h.p. steam turbines direct coupled to a multipolar dynamo of 200 k.w. They operate under 200 lb. steam pressure at the governor valve, and an Alberger condenser is used, from which the water is returned to the hot well. Distribution is on the three-wire system, it being deemed advisable to adopt this in preference to any multiple voltage method seeing that the mechanics are chiefly uneducated Mexicans. Group driving is mostly in vogue, and the normal pressures are 250 and 500 volts. Our contemporary the *Electrical Review*, New York, gave a fully illustrated account of the plant in two recent issues.

The Pacific Coast Electric Transmission Association.

Our contemporary, the *Journal of Electricity, Power, and Gas*, San Francisco, for August, contains full particulars of the remaining papers read before the above convention in June last. Our Californian friends are so well versed in extra high-voltage transmission that it is not surprising to see details of a sixteen-mile 80,000 volt transmission line. A Paper by Mr. A. C. Balch gave some valuable data regarding this line. Some special insulators for the Kern River transmission scheme were needed, and it was decided to submit various types to test pressures. No difficulty was experienced with the new insulators, and the line voltage was run up to 80,000 volts. A sharp rattling, audible at a hundred yards, was emitted, and at night the wires of the line were distinctly luminous, being easily traceable into the distance. The luminescence was visible at times, at distances up to a mile. After a time various insulators gave out and shut-downs were occasioned. The conclusions arrived at were that with new insulators all went well, but to ensure freedom from break-down the insulators were best cleaned once or twice yearly.

Errata.—*We regret that in our last issue the illustration of the Safety Colliery Switch on page 142 was ascribed to the Helsby Cable Co. instead of to the St. Helen's Cable Co., the Makers.*

Acknowledgment.—*We omitted in our last issue to acknowledge the courtesy of our contemporary, the "Electrical Review," New York, in lending photographs to illustrate the description of the Boston Edison Co.'s Plant.*



A classified list of Traction and Transport articles will be found in the World's Electrical Literature section at end of magazine.

Surface Contact Tramways in France.

By M. VINGOE.

IN view of the efforts made from time to time to equip certain towns and cities in the United Kingdom and elsewhere with tramways operating by means of surface contacts we have been examining the position of some foreign installations and give below a review of the present standing of the more important lines in France, now, or until lately, using surface contacts over the whole or a part of their system. The general reasons for installing surface contact systems in city streets are too well known to need lengthy repetition, and it is only necessary to mention that the aversion of certain municipalities to the unsightliness of the trolley lines is perhaps the main *raison d'être* of the surface contact, especially on the Continent. Minor causes exist in the difficulty of installing the slotted conduit system over certain routes, bridges, &c., through the existence of shallow underground obstructions, the great expense and, in a few instances, the inconvenience of the trolley line.

There may, no doubt, be cases where a good surface contact system is not out of place, for instance, as has been suggested several times, in some sea-side pleasure resorts zealous for their artistic reputation, and not burdened with much vehicular traffic, the essential conditions, being of course, safety in operation for both man and beast, absence of street obstruction, and general efficiency. Apart from these considerations it is urged that there is not a great deal to be alleged against a well-equipped surface contact line, from the public standpoint. But are such systems safe and desirable in the light of present experience? This is the question to which we have been giving some attention, and results at present obtained do not show that a system with the necessary mechanical and electrical perfections is in all cases objectionable. It must needs be appreciated that, in any case, a surface contact system, from its very nature, is more troublesome to maintain than a trolley line, or even a slotted conduit, but this again is more a matter for the company operating such a road than for the general travelling public.

Surface contact systems are, at present, in operation in few localities in England. We do not intend to refer here to the Lorain system installed at Wolverhampton; our readers are too familiar with all the details of the plant both from the point of view of maintenance and operation to call for further remark. There are, however, in operation, especially in France, a number of more or less well-known systems, such as the Diatto, Cleret, Dolter, Cruvellier, and that of the General Electric Company (Potter type), referred to later.

The Dolter system has recently been adopted for the town of Torquay. We learn that this same system just failed to be accepted at Dresden, the ancient capital of Saxony, a town very sensitive of its æsthetic reputation, where however, they have now placed in service accumulator cars, weighing forty-four tons empty, with a carrying capacity of ninety-eight passengers. The Dolter system is actually in service at Paris, and from observations which we have made, it would appear that its success there is due rather to a negative set of causes than to its intrinsic merits as a system. The length of line in service since 1900, is about two miles, nine-tenths

of which is through the Bois de Boulogne at the west of Paris, where it is undisturbed by neither horse nor foot traffic. It also crosses a public bridge, but 90 per cent. of the traffic over the bridge is composed of automobiles and bicycles.

This system has to encounter the same objections and meet the same difficulties as most other systems in which the mechanism is used on the streets, including the Cleret, Cruvellier, Diatto, &c. The chief of these is leakage. The leakage currents cause arcs between the carbon tipped contacts and the street plugs and lamp-black is consequently formed, gradually coating the interior surface of the small pocket below the contact in the street, in which the mechanism is placed. The insulating material used on the inside surface of the contact plugs also becomes covered in this way, and a difference of potential may be caused, ranging from 40 to 200 volts or over. Between these two voltages there is sufficient current to kill horses, and this is what has occurred in the Diatto and some other systems. The Dolter installation in question appears to be an exception, according to the claims made by its promoters, no deaths to horses having as yet occurred: this is easy to understand when we bear in mind that the line passes through a public park, with a semi-private right of way, this being the only portion equipped with the Dolter system, except the bridge above mentioned. The remainder of the line (about three miles) is equipped with the overhead trolley. It is certain that horses have been killed on all the other surface contacts systems in France, of which there are quite a few in Paris and neighbourhood. The Diatto system is worked over a length of some ten or twelve miles within the city limits, and the Cleret system is also represented by lengths of a few miles.

Although the lines operated by trolley and underground conduit in and around Paris, and even those worked by accumulator cars continue to pay in some cases respectable dividends, yet there is not a single company exploiting any considerable length of surface contacts which has yet succeeded in paying a penny dividend throughout its existence. This is, of course, accounted for by the very heavy maintenance expenses.

The Est Parisien Tramway Company is very much interested in the Diatto system, and, except where the overhead trolley line is authorised, all its cars use the surface contacts within the city boundaries. This system was installed along the rue du Quatre Septembre in 1900, and ran, with the usual interruptions, until the city of Paris commenced the shallow underground line of the Metropolitan Railway, running beneath the street, and known as the No. 3 line. This opportunity was seized upon by the Est Parisien Company, and by dint of strong influence on the grounds that the works for the new line interfered with the working of the contacts, they obtained the temporary permission to instal a trolley line, which however, still remains, despite the fact that the No. 3 line has been completed several months. The city protests and the Company retort that they (the city authorities), having disturbed the installation, should bear the expense of its repair. Feeling now runs high over the matter, a certain section being opposed to the replacing of the surface contacts and all being against the retention of the trolley line in the centre of the city. The finances of the Est Parisien preclude the consideration of the conduit system.

The Nord Parisien Company also runs a section of its lines within the city on the Cleret system, an improvement on the Diatto, but the expenses connected with the maintenance swallow up a very large portion of the profits which might otherwise be derived from the important and populous district covered by their network.

In Paris considerable quantities of salt are used at certain times during the winter months, to melt snow, and also to prevent the dreaded "verglas" or frozen sleet, which is very apt to form in the streets at nightfall, and which is dangerous alike to foot and horse traffic. The salt water on the streets, and especially between the tracks rather helps the leakage currents which are the bane of the surface contact systems, and horses stepping on the plugs are killed rather frequently. At least this has happened in past winters, and for this reason the lines are from time to time shut down for a half or a whole day until the tracks can be cleaned ready for use again. Where salt is not used, the snow itself has proved sufficient to stop the cars running for hours at a time.

The experience of the Paris Municipality has been such that it appears extremely doubtful whether any more concessions will be granted by them to tramway promoters for lines to be operated on the surface contact system. As trolley lines have been hitherto debarred from entering the better-class districts, except temporarily, the alternative electric system apart from accumulator cars, which are now unfavourably viewed in Paris, is the more expensive slotted conduit, a deal of which is in service, and of which, at the time of writing, considerable extensions are taking place.

In view of the havoc which is caused by the use of salt in the Paris streets, it will be interesting to note whether the same will be liable to happen in Torquay or other

sea-side resorts where streets are habitually watered with sea-water, from hygienic as much as from economical reasons.

There is one locality where a surface contact system has given a certain amount of satisfaction, although this line, as explained later, has been transformed. This runs through the Principality of Monaco. The Principality is surrounded, except on the coast, by French territory. The system employed was that developed by the General Electric Company of Schenectady, commonly known as Mr. Potter's system. This installation, one of the few to give fairly satisfactory results, presents rather more than usual interest.

The French Thomson-Houston Company were responsible for the installation which was opened for service early in 1898, this being the first line of its sort to be built by the contractors in France. The tramways on either side of the Principality were operated by trolley line, which the Prince of Monaco would not then permit in his domains. The surface contact system was the alternative chosen and some five or six miles were eventually constructed. The first lines were about three miles in length. The gauge employed was 3 ft. 3 in. The route is very hilly, the grades being about 8 per cent. and even 9 per cent. on the Avenue Monte-Carlo. The minimum radius of curves is 65 ft. The studs finally adopted were about the size of an ordinary wooden paving block, and were ranged in two rows, about 10¾ in. distance from the nearest rail, one row being used as contacts from which the current was derived from the feeder, the other series of contacts being connected to the return circuit. The cars were arranged to hold thirty-six persons, their length being 26 ft. Type G.E.-53 motors with B-16 controllers (General Electric Co.) were used. The cars, which were never very crowded, followed each other at ten or fifteen minutes interval. The pressure employed was 500 volts.

The system, as above stated, has just been replaced by the trolley. It appears that the operating company, who own the lines on either side of the Principality, at last obtained the right of way through Monaco for the trolley line, and as both sides of the district were worked in this manner, it was only natural to remove the contacts. When the lines were first laid, some horses were killed in Monaco, owing to defective contacts; but the inquiry held clearly showed that the accidents were due solely to defects in the contacts, and had nothing to do with the action of the switches. The latter, once they were sufficiently insulated both from one another and from the ground, gave no trouble. When first installed, the switches were suspended on wood supports, and the insulation proved insufficient. With the use of porcelain insulators, these difficulties were overcome. This is evident by the fact that the extension, carried out in 1899, gave satisfaction from the start. Another cause of accident we learn, was the fact that trenches in which the lead-covered cables were laid, had to be blasted out of the solid rock. The trenches were cut too shallow, and the cables in consequence worked to the surface, where they were injured by road workers. The roads in the district are all macadamised. The cables were relaid, and in the extension the error was not repeated. A source of trouble at times was the insulation at crossings. This was avoided in Monaco by somewhat raising the level of the paving, so that the contact skids did not touch the lines crossing the system.

As seen from the above details it was not because the system proved defective, that the contacts were removed, and in fact the line was in service until 1903, and gave good results, but with high maintenance charges. The troubles recorded for this installation were not very serious, and tend to show that a well-planned system of surface contacts may find a place at least in certain thinly peopled districts where local feeling forbids the use of the trolley line, and the slotted conduit is debarred by the great expense of installation.

In this connection it may be mentioned that there are still some fifty miles of horse tramways in service in New York city, and certain of these will offer obstructions in the way of a slotted conduit being installed. It is stated that the authorities will shortly ask for proposals for a surface contact system, and it is very probable that the General Electric Company's system, the results of whose operation is outlined above, may be laid down. The results of our investigations among the installations above referred to lead us to the conclusion that the following improvements are necessary before surface contact systems can be considered a practical scheme for the majority of our towns and cities. Some of the recommendations are not easy of realisation.

(1) Render the street plug watertight.

(2) Design an incombustible switch.

(3) Design a street plug admitting of easy inspection.

(4) Close sectioning of feeder cables to permit easy localisation of break-downs.

(5) Instal a security device operating not only when the street plug is under load, but also when leakage currents are present.

New Locomotives on the Jungfrau Railway.

SOME important additions have been made lately to the rolling-stock on the Jungfrau line, there being now in operation six locomotives of widely different design. Three of these, Nos. 1, 2, and 6, are by Brown-Boveri and Co. of Baden, while the others are by Oerlikon and Co. The mechanical portion of each is identical, having been executed by the "Société Suisse de locomotives et machines" of Winterthur; the electrical portion especially in the more recent engines, however, presents some interesting features. We will, in this article, confine our attention to locomotives 1, 2 and 6, dealing with the others in a subsequent issue.

Engines 1 and 2 (Fig. 1) are identical in design. The body of each locomotive is supported by springs on two axles, independent of the driving axles, the latter revolving in bearings fixed rigidly to the truck. Normally the engine is combined with a passenger coach, the end of which rests directly on it, being coupled to the engine by a device similar in principle to the universal joint. The locomotive can, however, also run alone, or haul waggons. Three brakes, each of which has sufficient power to stop the train, give complete security. Two are ordinary hand operated shoe brakes, bearing on the right and left pulleys of the toothed wheels in gear with the rack. The third comprises a centrifugal apparatus which acts automatically on the band-brake of the motor axles, and on the switch simultaneously, when for any reason the speed of the locomotive exceeds a given limit. This brake can also be operated by hand at any time from the driver's or the passengers' platform. A safety clutch is provided, which grips the cog railhead and prevents the toothed wheels from leaving the rack. The jaws of this clutch can be adjusted to any angle. When travelling down long slopes without current and with the hand-brakes alone in action, the latter are cooled by a special device.

Each locomotive weighs 13.8 tons and is equipped with two 3-phase motors of 150 h.p., each under normal conditions at 500 volts and 760 r.p.m. and 38 cycles. These are completely independent, each driving through suitable gearing one of the toothed wheels in gear with the rack. The total gear ratio for each motor is 11.5 to 1, the gearing being split up into two sets of ratios 1 : 5.25 and 1 : 2.22 respectively. The toothed wheels, whose diameters measure 700 mm., run at 65 r.p.m., their total

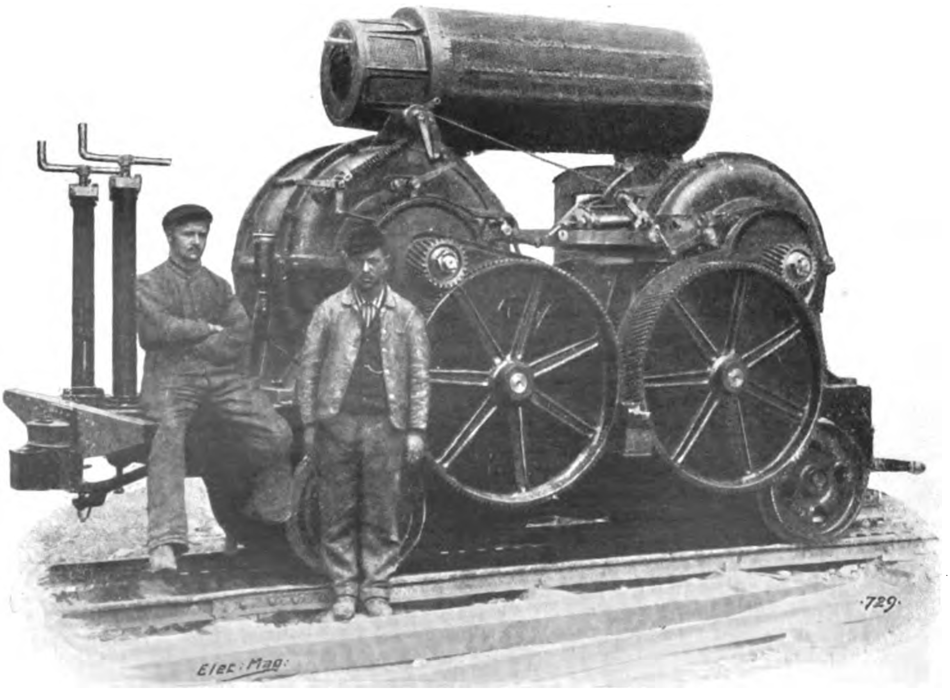


FIG. 1. NOS. 1 AND 2 TYPE LOCOMOTIVE, JUNGFRAU RAILWAY.

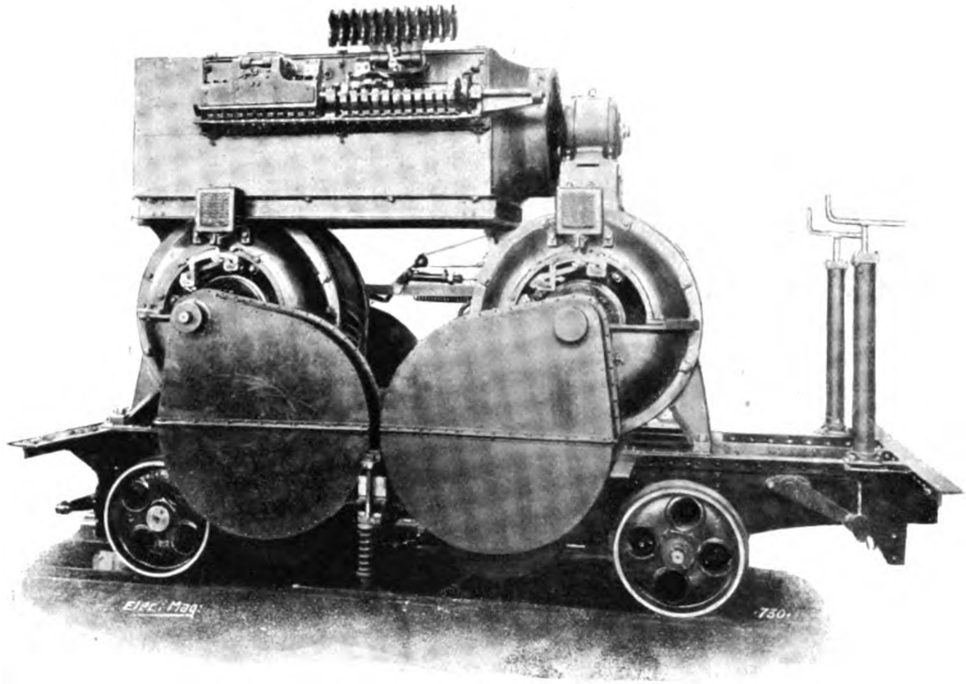


FIG. 2. NO. 6 TYPE LOCOMOTIVE, JUNGFRAU RAILWAY.

pressure on the rack amounting to 9,000 kg. The normal speed, whether during ascent or descent is 8.1 km. per hour. The controlling and starting resistances are above the motors, to which they are fixed by cast-iron supports. A reverse-speed commutator is arranged under the roof. Current is collected from four trolleys, two for each phase, the rails acting as third phase conductors. An ammeter, lightning arrester, four fuses and a tachometer complete the electrical equipment. When the motor connections are arranged for travelling downhill with short-circuited rotors, the motors become generators the moment the speed attains synchronism. Thus the energy developed by the train returns to the power-house, while a constant speed is soon attained equal to synchronism speed—a very small quantity due to negative slip.

There is, however, a serious drawback to this arrangement. Should there be several trains descending simultaneously, the power-house might, at any moment, be receiving more energy than it is giving out, turbines and generators would then run away and the speed of the motors attain a very dangerous value. To prevent this, resistances are provided at the power-house to absorb the surplus power.

No. 6 is a new locomotive of very original aspect and design (Fig. 2). Before being used to haul passenger trains, its first duty will be to assist in clearing away the rubbish from the tunnel which is now being completed, and as the trains employed at this duty will weigh some ten tons more than passenger trains, certain portions of the engine have to be much more substantial in design than in the former locomotives. The total weight of the engine is 16.8 tons. The electrical equipment, as far as the motors and the power are concerned, is similar to that of the former engines 1 and 2. When going uphill, the speed is constant and about 8.1 km. When travelling downhill, special means are devised to cut off all electrical connection with the line when desired, it being then possible to adjust the speed to any value between 8.1 km. and 5 per cent. of this maximum speed. Messrs. Brown-Boveri claim that no other engine on the line can show such a broad range of speeds under similar conditions. In some of the other engines on the same line the speed is regulated by making the motors work as generators, with resistance, provided to absorb the generated current, while a suitably adjusted exciting current is supplied by a supplementary generator arranged on the same axle as the motor. The system is quite different on this locomotive: the motors are specially designed to allow of

being connected up so as to work as motors, and asynchronous self-excited generators when going downhill. The rotor carries three slip-rings for the insertion of starting resistances and a commutator on the other side whose brushes are lifted out of circuit by a triphase magnet and a system of levers when the motors are fed from the line. The starting resistances can also be used as absorption resistances, and are constructed to absorb 170 kwts. for a reasonable length of time. A ventilator is also provided for cooling these resistances.

NORTH METROPOLITAN ELECTRIC TRAMWAYS.

THE first section of this company's North London Lines was recently opened for traffic and a glance at the accompanying map will give some idea of the extensive system to be directly operated or leased the Metropolitan Company. The system will link up with the North Metropolitan Tramways in the County of London, and form valuable means of communication to and from the northern outskirts. The lines now opened were bought in November 1902, from the North Metropolitan Co., as horse lines and subsequently electrified. The new section is 8½ miles long, and during reconstruction the road has been lowered under three railway bridges, double track has been laid throughout and several thoroughfares have been widened. Partly side pole and partly span wire construction is used. Current is purchased from the North Metropolitan Electric Power Supply Co., who have large stations operating at Brimsdown, Willesden, and a smaller plant at Hertford. The Metropolitan Electric Tramway has acquired a controlling interest in the following undertakings:

(1) Tramways in Middlesex (7¼ miles) and in the county of London (1¼ mile) owned by the company, reconstructed for electric traction on the overhead system and opened on July 22.

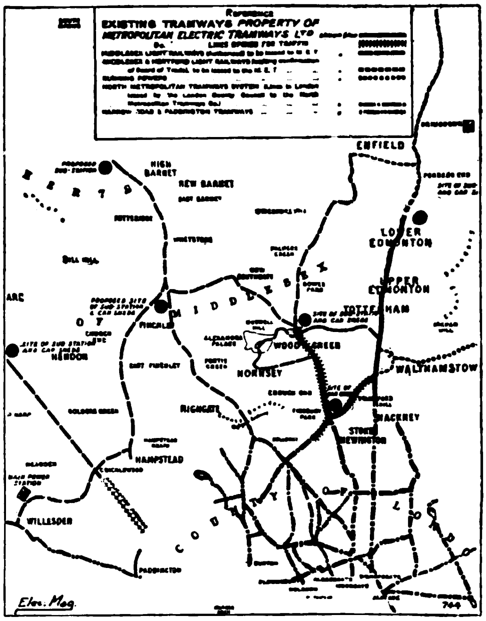
(2) North Metropolitan Tramway Company's lines in the county of London (48¾ route miles), leased to the North Metropolitan Company till 1910, and at present worked by horses.

(3) Light Railways in Middlesex and Hertford (37½ miles authorised and 11½ miles in course of construction for electric traction on the overhead system), owned by the respective County Councils and leased to the Metropolitan Electric Tramways, Limited.

(4) Harrow Road and Paddington Tramways (2¾ miles), now worked by horses and to be converted to electric traction on the overhead system.

(5) North Metropolitan Electric Power Supply undertaking, already in operation with stations working at Willesden and Hertford and a station at Brimsdown, supplying power for the electric tramways.

Its chief terms with the Middlesex County



PLAN OF NORTH METROPOLITAN TRAMWAYS.

Council are favourable, and by them the latter constructs the track and receives 4½ per cent. interest on the capital cost of same, and 45 per cent. of the company's profits after payment of above 4½ per cent. and 4½ per cent. on the company's outlay. The company provides overhead equipment and cars and receives 55 per cent. of net profits after 4½ per cent. is paid on its capital outlay and that of the Council. The company's lease extends till 1930. The entire system is a most comprehensive one, and illustrates how a combination of public interest can be effected in a single company which provides a tramway service otherwise difficult to realise with many local authorities in scattered districts.

FRENCH ELECTRIC MAIL-VANS.

THE French Postal authorities have recently placed an order with Messrs. Mildé, of Paris, for several electric vans to transport mail-bags between the various post offices in the city. Externally the van is similar to the horse-vehicles in actual service, having very high seats provided for driver and postman, which afford a good survey of the road, as well as of the rear of the van, so that the bags have little chance of being taken on the way. The vehicle weighs 1,740 kg., 880 on the front and 860 on the rear axle. The bags are carried in the body of the vehicle, being thrown in through an opening on the top. The carrying capacity is 1.5 m. or 600 kg. The total weight including that of the men in

charge would be about 2,500 kg. The specified mean speed is about 18 km. an hour, which is a maximum speed of 22 km. p.h., if the traffic and gradients be taken into account. The storage battery consists of forty-four Heintz accumulators of 150 a.h. capacity, placed in one single box, and providing for a 40 km. run. As the daily run for each van is about 60 km. recharging must occur at least once during the day. and special means are provided for doing this easily and rapidly. The battery is placed in a recess in the front underneath the driver's seat, being held in position by a small railing. When recharging is necessary the box is slid out of the van on specially provided rollers and small tubes, and placed on a chariot also fitted with rollers, and on a level with the recess. A charged battery is then substituted in the same manner. The elements are mounted on ebonite casings. The motor is of very solid construction, being rigidly fixed to six points of the chassis, which is itself supported on very long and elastic plate-springs. The constant distance which should exist between motor and wheel axle is adjusted by means of screws. The motor has two armatures, each of which drives one of the rear wheels by a separate chain, the object of this arrangement being to prevent accidental stoppages due to the failure of one of the armatures. Should this happen, then the sound armature remains to do the work, though the adhesive force may sometimes be insufficient when the road is muddy and slippery.

Some vans will be fitted with pneumatic and others with solid rubber tyres, so as to test the respective merits of each kind. The motor is so arranged that the same flux traverses both armatures, thus equalising the load on each. The induction in the magnetic circuit is very low, and this arrangement secures a broad range of speed as well as a good starting torque.

ELECTRICAL EXPERIMENTS ON THE SWEDISH STATE RAILWAYS.

THE suggestion of the Managers of the Swedish State Railways to organise electric railway trials on two lines in the neighbourhood of Stockholm, has been lately discussed in the technical press. The funds asked for this purpose have now been granted by Parliament. In the *Schweizerische Elektrotechnische Zeitschrift*, R. Dahlander states that the Tomteboda provisional power-station is in course of construction, the electrical locomotives and motor-cars having been ordered recently. The power-station is operated by steam, two de Laval steam turbines, each direct-coupled to a single-phase generator, being installed there. By altering the speed of the steam turbine, any desired period between fifteen and twenty-five can be obtained. By switching the coils of the two transformers installed in the power-station, the tension of the overhead wire may be adjusted between 3,000 and 20,000 volts. Two electric experimental locomotives have been ordered, namely, a two-axle locomotive with two alternate current series motors, transformer, and induction regulators from the American Westinghouse Co., and a three-axle locomotive comprising three such motors, transformers, and coil switch from the Siemens-Schuckert Werke. Both locomotives are designed to allow of different voltages at the running wire being used between the above limits. In addition to the two trial locomotives, a passenger train is to be fitted electrically for the local traffic, this train to consist of four truck cars. The electrical equipment of this train has been entrusted to the Allgemeine Elektrizitäts Ges. Two of these cars are designed as motor-cars, each with two Winter-Eichberg motors, including starting and regulating devices analogous to those in use on the Spindlersfelde Railway (see *Electrical Magazine*, vol. i. p. 161). In addition, each of the four cars will be fitted with electric heating devices. The motors are designed for 6,000 volts and twenty-five periods. As on the Swedish State Railways, vacuum brakes are in general use, both the above motor-cars and the three-axle locomotive are fitted with electric suction-air brakes, while the two-axle locomotive is being provisionally fitted only with a hand brake. Both the locomotive and motor-cars have been ordered without collectors, no decision having so far been arrived at as to the design of the overhead wire. The rolling stock is to be supplied at the beginning of next year so as to allow of the trial runs being commenced in February.

TRACTION NOTES.

Fireproof Material for Electric Cars.

NEW materials termed asbestos lumber and magnesia lumber have been recently introduced by a New York firm, for the fire-proofing of railway cars. Careful tests have been made of the electrical resistance, insulation, and fire resisting properties of both these with satisfactory results. Absorption tests proved both materials subject to damp, but capable of being dried out again. As a result of the various tests, the National and New York Boards of Fire Underwriters have agreed to specify the materials. The New York City Railway Co. and the Interborough Rapid Transit Co. are using the material for fireproofing car bottoms, and protecting the third rail in the subway, respectively. A number of other important firms and railway companies are also adopting

the material. Kinsbey and Mattison are the inventors of both substances.

Electric Driving. Instructions for Motor-men.

THE Interborough Rapid Transit Railway Co., New York, is faced with the problem of training 3,000 men to the use of the electric railway apparatus to be employed when the subway is opened. This company also operates the Manhattan elevated, but the subway crews will be kept quite distinct. The company has fitted up a special car for instructing its employés, this containing every portion of the train equipment exposed to view, and handy for inspection. Motor-men are led up through preliminary lessons from control instruction books through examinations to operating on a stationary car, thence to a running car on which the signal system is learned and so to a close knowledge of the gradients and road, until qualified to take command of a train. The latest type of multiple unit system is installed on the train together with all the braking appliances in common use. The *Street Railway Journal* (August 20) contained a full description of the equipment.

A Freight Truck with Motor Wheels.

IN a recent issue of *Machinery*, New York, a description appeared of a freight truck in which electro-motors were used in the wheels themselves. The armature shaft carries a pinion at each end and the motor being hung on the driving shaft, the pinions engage with two large bevel wheels facing each other and bolted together. The motor is between these wheels and the pinions drive them from exactly opposite points. By this arrangement the motor becomes part of the wheel and the tractive effort can be increased by adding motors to hitherto idle wheels. A freight truck arranged for a three-ton load and fitted with four 2-h.p. motors, was recently tested in New York. The batteries consisted of 42 cells with a capacity of 200 ampere hours. With a 9,000-lb. load or a gross weight of 16,725, on a 10 per cent. grade the current taken was 95 amperes at 80 volts or 10.18 h.p. If motor efficiency be taken as 74 per cent. and transmission 96 per cent., but 7.23 h.p. was actually taken in moving such a weight uphill with the same load on the level, the instruments showed 27 amperes at 78 volts.

Heavy Traction with A.C. Currents.

IN a paper read before the recent Annual Convention of the Canadian Electrical Association, Mr. P. M. Lincoln advanced arguments for the use of alternate currents for heavy railway work. The advantages of using a single overhead conductor at a high voltage, and the elimination of the rotary converter were emphasised. A.C. currents were considered superior on all points to continuous currents. Discussing the relative merits of electricity and steam, he considered that with reduced weight of locomotives, uniform torque, perfect balancing of drivers and fewer repairs, electricity had a marked advantage, while in addition multiple control was possible, water-power could be utilised, and undoubted economies were obtained. Statistics indicated that where electricity was generated by steam and applied to railway operation the lines could be more economically operated than by steam locos, and if water-power were utilised as it could be in America and Canada, the economies were still more pronounced. The writer concluded by remarking that the proposition to operate lines by electricity was worth investigation, and the electric companies would not only equip trunk lines, but also guarantee their successful operation.

Aspect of Electric Traction in Germany.

AT the end of 1902, Germany had a total length of street railways of 1,906 miles, practically all operated by electricity. These lines were changed from horse to electric traction in about four and a half years, and the former are now almost extinct in Germany. German experience is not altogether favourable to municipal management of tramways, and in one instance—Barmen—the question of leasing the lines to a company is under consideration. A number of large tramway interests are springing up in Germany, among the largest being the Great Berlin Street Railway Co., operating 200 miles of track, 144 of which are owned, and the remainder controlled by the company. Last year it ran 40,400,000 car miles, carried 295,000,000 passengers, and received in fares £1,756,250. The capital of the company is £5,954,902. The expenses of certain branches of tramway work in Germany, have increased under electric traction. The motor-men and conductors who have formed powerful unions, have increased the wages by 50 per cent. Rails are also more costly to maintain, and an item unlooked for when laying them, has since caused heavy outlay; the copper bonds have materially increased their resistance, and unless replaced by the welded joint, they require periodical renewal. In certain instances the fares are rigidly fixed by the authority granting the tramway concession, and there are also cases of municipalities requiring a certain percentage of surplus over a particular sum distributed to shareholders. The United States Consul who has collected information on this matter, states that despite municipal restrictions, heavy capital cost, and many other obstacles, the street railway companies have flourished on account of the increased traffic their lines have occasioned.

Readers are referred to the World's Electrical Literature Section at end of Magazine for titles of all important articles of the month relating to Lighting and Heating.

The Proposals of Mr. Wilmshurst.

By the ASSOCIATE EDITOR.

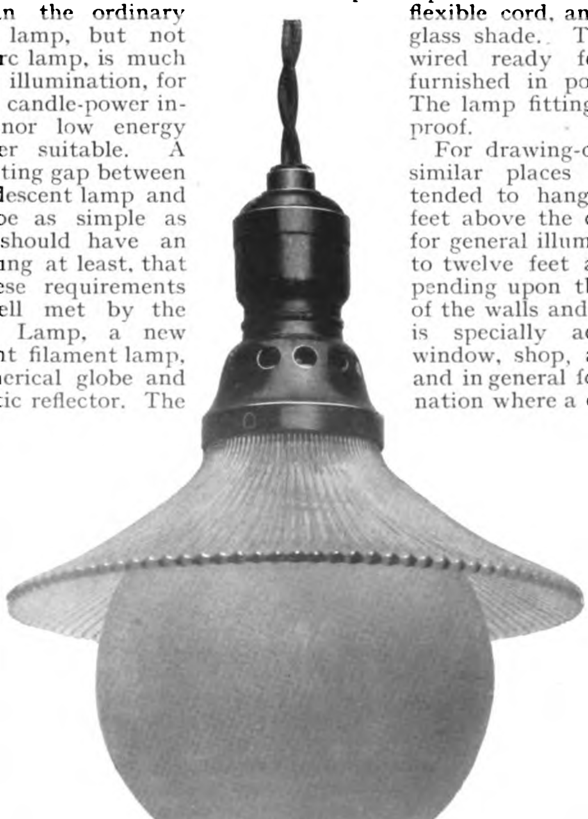
THE President of the Incorporated Municipal Electrical Association has lately touched on a subject that is full of difficulty due to the variety of conflicting interests with which it is concerned. We have also called attention to the matter in a slightly different form in some of our recent issues, and are therefore glad to find that it is likely to receive attention and to provoke discussion. Mr. Wilmshurst makes in fact three proposals. His first is to the effect that the central station engineer should periodically renew consumers' lamps either free of charge or on easy terms ; his second is that he should periodically inspect consumers' lamps, in order to see that they are in good order, and his third is that he should undertake, free of charge, to test and report on consumers' lamps. There is no mistake about the radical nature of these proposals. Neither is there any mistake as to the nature of the opposition called forth in certain quarters. The state of affairs which Mr. Wilmshurst proposes to remedy is admittedly bad, and in his own interests, speaking as a central station engineer, he considers that he is better fitted to deal with the matter than anybody else. It is quite easy to see that his proposed remedies may interfere seriously with the business of the private contractor, and even possibly with that of the vendor of cheap lamps. But neither the one thing nor the other is certain. The work which Mr. Wilmshurst proposes to do is at present satisfactorily done by nobody. Scarcely any of it falls within the province of the consulting engineer, or to put it in another way, very few consulting engineers do this kind of work, the renewal of lamps on easy terms being obviously no part of their business, and the free testing of consumers' lamps does not sound likely to bring much grist to the mill. In any case they are seldom called upon to advise in these matters. Besides which, consulting engineers are practically unknown in small provincial towns. There is nothing to prevent the contractor from offering his services in the emergency, and he would probably tell us that he has already done so with satisfactory results to everybody. To a large extent what he says is probably true. No doubt the work which Mr. Wilmshurst proposes to do is already done to some extent by the contractor, who finds in it a small source of revenue. Moreover if the central station engineer were to step in, the contractor would lose his hold of his customer. After all, the fault to some extent lies with the consumer himself. If he persists in using blackened lamps, that is his own fault, and a very little experience ought to cure him of this. He probably complains to the engineer, who explains the matter to him, and the trouble from this source ought not to recur. But in so far as the fault is not that of the consumer, it must, we think, be laid on totally different shoulders. In buying lamps, the consumer is perfectly helpless. He generally buys at random, having nothing but price to guide him. And such is the state of common knowledge on the subject that it is uncertain whether by buying the dearest lamp he is likely to be any better served than he would be by buying the cheapest. The figures that are frosted on the bulb are often little better than a form of decoration, and it seems hopeless to expect that legislation will ever provide that all lamps should be under a guarantee as to candle-power and

efficiency. And seeing that it is in this matter that the consumers' interests are most vitally affected and that there is at present no means by which he is protected against the uncertainties of the vendor, it seems as if Mr. Wilmshurst's proposal to supply lamps on easy terms, or better still at the market rate, might meet the case. We should much regret to see the contractor ousted from this branch of his business; but if the station engineer supplied at the market rate, there would be nothing to prevent the contractor from doing the same, and there need be no transference of business. The contractor and the central station engineer have no mutually conflicting interests. Quite the contrary. If then the central station authorities gave the contractor the benefit of their lamp-testing results, the consumers' interests might be effectively safeguarded without any loss of business on either side.

THE B.T.H. MERIDIAN LAMP.

An efficient electric illuminant, more powerful than the ordinary incandescent lamp, but not so intense as the arc lamp, is much needed for general illumination, for which neither high candle-power incandescent lamps nor low energy arcs are altogether suitable. A lamp to fill the existing gap between the ordinary incandescent lamp and arc lamp should be as simple as the former, and should have an efficiency approaching at least, that of the latter. These requirements appear to be well met by the B.T.H. Meridian Lamp, a new type of incandescent filament lamp, having a large spherical globe and translucent prismatic reflector. The lamp is specially designed to give an almost perfect distribution of light in the lower hemisphere with a comparatively small expenditure of energy. The bulb is obscured, and when the lamp is burning it has the appearance of a globe of soft, brilliant white light.

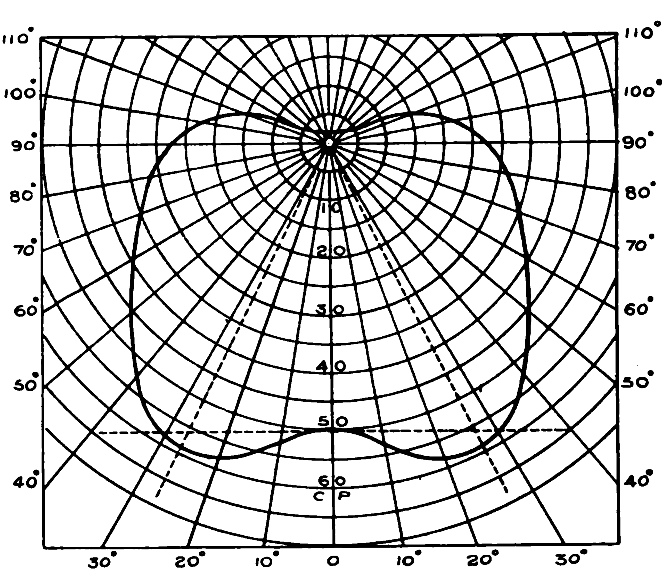
The excellent light distribution in all useful directions is shown in the accompanying diagram. The maximum candle-power is about fifty-eight at an angle of 30° from the vertical, and an average candle-power of about fifty-five is well maintained over an angle of 60°. The dotted triangle shows that this peculiar distribution produces a practically uniform illumination of great intensity over a circular field, whose diameter approximates its distance below the lamp. The lamp has been specially designed to give this distribution of light, which makes efficient illumination possible from a source of light above the line of vision, a method of lighting involving the least strain on the eyes. It is, therefore, particularly adapted for ceiling suspension. The Meridian lamp is made in only one size, giving fifty-five candle-power and consuming 120 watts, and is supplied in voltages from 100 to 125 only. The lamps may, of course, be operated two or more in series, on circuits of higher voltage. The bulb is spherical, five inches in diameter, and is frosted or obscured. A special lamp holder is used with the fittings.



Meridian Lamp Complete.

The type of fitting used consists of the lamp, lampholder, three feet of green silk flexible cord, and special prismatic glass shade. These are supplied wired ready for use, and are furnished in polished brass only. The lamp fittings are not weatherproof.

For drawing-offices, libraries, and similar places the globes are intended to hang about four or five feet above the desks or tables, and for general illumination about eight to twelve feet above the floor, depending upon the reflecting power of the walls and ceiling. This lamp is specially adapted for show-window, shop, and office lighting, and in general for all kinds of illumination where a downward distribution is desirable. To obtain the best lighting effect in art galleries the source of light should be above and behind the observer. As intensity of illumination varies inversely with the square of the distance from the source, a Meridian lamp will give an illumination of one candle foot, on a surface seven feet below the lamp, while if the lamp were ten feet above the plane of illumination, the inten-



LIGHT DISTRIBUTION CHART. B.T.H. MERIDIAN LAMP.

(*See opposite page.*)

sity would be one half a candle foot. For general illumination the average intensity varies from one-half to two or three candle feet, depending on the requirements and the character of the surroundings.

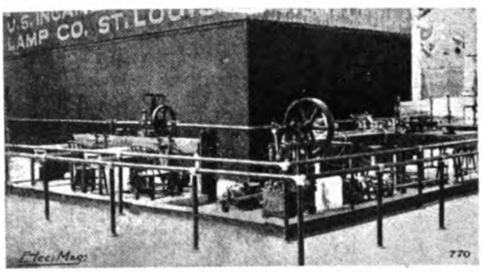
ELECTROSTATIC ILLUMINATION.

FOR any one who has the use of a Wilmshurst machine the following experiment, described by Mr. Howard Bailey, gives a very striking result. A glass goblet is mounted on a revolving platform. A narrow strip of tinfoil is fastened with shellac varnish to the surface of the glass as follows. Starting beneath the foot of the glass from a point immediately below the stem, it is taken to the edge of the foot: it follows the edge for about an inch, and then passes in a curve across the base, and ascends the stem; then it passes round the bowl in a sinuous course to the rim, which it follows for about one-third of its circumference; after which it descends on the inside and terminates at the bottom. The tinfoil on the outside of the glass is divided by a penknife every eighth of an inch, the parts inside and beneath the glass being left undivided. Current is then led from a Wilmshurst machine to two terminals; the one terminal is connected to the one end of the tinfoil strip, and similarly the second terminal makes contact with the other end. As soon as current is led into the apparatus, a spark is seen at each point where the penknife has cut through the tinfoil; and if the goblet is rotated by means of a handwheel and pulley, the effect of the persistence of the image on the retina causes the whole of the glass to be illuminated as shown. A variety of small and peculiar effects can be obtained by making some of the gaps larger than others, in which case larger sparks would be produced at these points. Naturally the experiment would be carried out in a darkened room, and under these circumstances when nothing is visible, not even the substance of the glass itself, the effect is very striking.

ILLUMINATED GLASS.

MAKING INCANDESCENT LAMPS AT THE ST. LOUIS EXHIBITION.

ONE of the most interesting exhibits at the exhibition at St. Louis is that of the United States Incandescent Lamp Company, who have thrown aside all sort of commercial reserve, and are showing daily to all comers their methods of manufacture. The installation, which is shown in our illustration, employs more than 20 operators, and turns out daily 1,500 lamps complete. Every stage of the operations is shown, and from this it would appear that there is nothing to conceal. In America the automatic part of the business, as it were, is almost brought to a state of perfection. . . . The arrangement of small devices

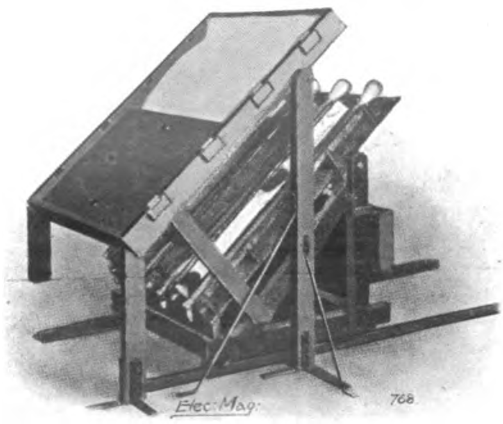


INCANDESCENT LAMP EXHIBIT, ST. LOUIS.

by which the work can almost be done with the eyes shut makes every process appear simpler than it really is. If any of our manufacturers think that their rivals in the United States have any ideas which they would like to introduce into their own methods of working, now is their time to find out. They should not hesitate to send one of their representatives to the United States, if only for the purpose of seeing this exhibit, from which probably they would learn much. The general principles on which the manufacture depends are, no doubt, the same in all parts of the world. The main interest lies in small mechanical manipulations, which may be novel, or may in their turn give rise to a fruitful suggestion for a labour-saving device.

THE COOPER HEWITT LAMP FOR BLUE PRINTS.

Various arrangements have been suggested for the application of the Cooper Hewitt lamp to the printing of the blue print. Such application is perhaps not quite so easy as might appear at first sight, seeing that arrangements have to be made on the usual system to tilt the lamps with a view to lighting them. Our illustration shows, at any rate, one arrangement, which has the merit of being at once simple and compact. The blue print frame is fixed in a position making an angle of about forty-five degrees with the horizontal, with its working side facing downwards. The lamps are carried on a separate framework, which is run in on rails after the lamps have been lighted. With four lamps, as shown, a print is obtained in less than two minutes; the lamps take from 100 to 150 volts each, and can, of course, be arranged two in series on 200 to 300 volts. An alternative arrangement is to place the blue-printing frame horizontally, in which case



Cooper Hewitt Lamp Printing Frame.

it can be more conveniently loaded; the lamps are then placed beneath it, and can be lighted by swinging the frame holding them about a pivot at its one end.

LIGHTING AND HEATING NOTES.

Electric Lighting in Bombay.

It is proposed to replace the present supply of electric current for the Municipal Offices and Crawford Markets in Bombay by having recourse to the Brush Company's mains. It has been found that the existing installation is proving defective owing to the ravages of the white ant and other causes. More particularly it is found that the excessive dampness of the atmosphere due to the monsoon causes the development of faults with a regularity that is undesirable. Hence it is thought necessary to make radical alterations in the installation, and to overhaul it generally. It was originally designed for 100 volts, but as the Brush Company supplies at 200 volts, that of itself would be likely to make the present insulation unsatisfactory, quite apart from the fact that things are none too satisfactory even as they are. It is, therefore proposed to put in a new installation, consisting of lead-covered wiring, which it is hoped will be proof against both the white ant and the monsoon. The current is to be supplied at 3 annas per unit, and the total annual working expenses are estimated at 10,375 rupees as against 11,227 on the old system, so that a slight economy is expected in addition to a greater regularity in the supply.

Electric Cookery.

As compared with gas cookery, electricity has its own advantages. In illustration of this fact, it is interesting to note that at Harvard University, where a kind of batter cake, called waffles, is much esteemed, and to such an extent that 250 of them are consumed during the luncheon hour daily, it is found that the special iron forms in which they are baked are more conveniently and economically heated by electricity. This arises partly from the fact that electrically heated irons can be heated on both sides at once, and this saves time, as with gas heating the mould has to be shifted round when the baking on one side is complete; and further, the oil or lard which is used to prevent the batter from sticking to the iron does not get burnt to the same extent with electricity as with gas. The economy of production is very marked, and one man with the new system can do the work of two under the old. Unfortunately it does not seem likely to be economical to adopt these improvements until there is a more general arrangement for supplying current at a cheaper rate for such purposes, without special meters, &c. The Americans, are however, developing a big business in heating appliances, and are said to be exporting large quantities of different kinds of apparatus for these purposes.

For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section at end of Magazine.

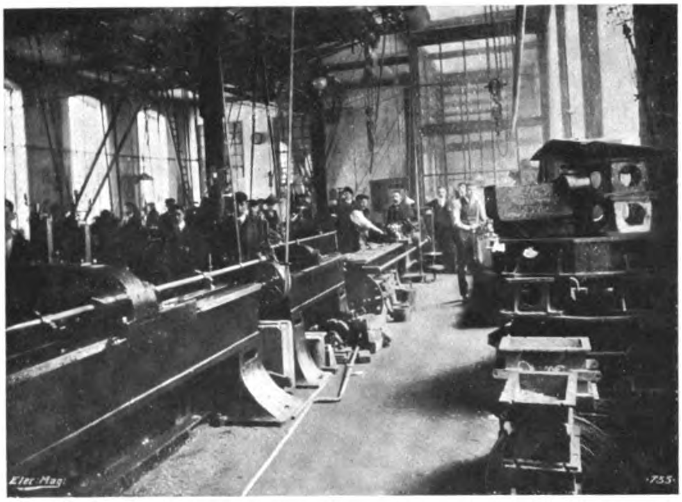
The British Post Office Factories.

By E. O. WALKER, C.I.E., M.I.E.E.

PROBABLY few people outside the post offices of the United Kingdom are aware that the great success achieved in dealing with the immense telegraphic traffic of the country is attributable largely to the skill and scrupulous care exercised in the manufacture of the instruments that are placed at the disposal of the technical staff which controls their operation. Not an improvement which genius and experience has suggested during the last fifty years, nor a defect which increasing vigilance can detect, has escaped the keen scrutiny of the factory engineers of the Post Office, who practically have to guarantee the accurate performance of the whole of the instrumental equipment of this vast system. A great deal of the manufacture of the more delicate apparatus is done entirely within the walls of the Government factories, and all that is made by outside contractors is examined there before issue.

The instrument factory is at Holloway, and speaking generally deals with telegraphic and telephonic apparatus. The general factory, at Mount Pleasant, in Rosebery Avenue, makes and repairs condensers, woodwork for switch and test boards, cables, batteries, pole-arms, &c. Most important work of a very special character is turned out in the former for the Wheatstone's Automatic System which is so widely and successfully used in the United Kingdom, for the Hughes Printer, for Delany's Multiplex Telegraph, and lately for Lodge's Wireless System, Creed's Perforator, and Murray's Type-printer. Some of this work has involved new designs in the factory, and all of it requires the application of scientific principles and technical experience and execution, which are not exhibited in a greater degree than in the postal factories in any part of the world. The Indian and Colonial Governments have indeed often come here to learn, and it is no exaggeration to say that if their telegraph systems have been successful, it is due to the object-lessons obtained here and to the

THE CONTROLLER, MR. J. W. WILMOTT, AND MR. W. S. HINTON, HIS PRESENT CLERK.



THE ENGINEERS' AND FITTERS' SHOP.

methods of doing business on the telegraph circuits of Great Britain which have always been so ungrudgingly disclosed to the engineer in search of information.

Some figures will render an idea of the volume of work done during the past ten years. There were made in that period—

1320 Wheatstone's Perforators.
264 Spring Receivers.
230 Receiver Trains.
145 Receiver Motors.
78 Hughes Instruments Complete.
2693 A B C Communicators.
2860 A B C Indicators.
5000 Standard Relays.

In addition to these complete apparatus, all telegraph and telephone instruments needing any serious repairs have been sent into the factory, in increasing numbers each year. In the twelve months of 1903 no less than 31,395 separate pieces of apparatus were repaired and made available for re-issue. Where slight repairs only are required the factory supplies the necessary parts to the local workshops. To fulfil such demands, during last year 435,000 parts were used up. Another unique feature of the factory work is the examination and overhauling of apparatus which has been out on loan to divisional engineers, chiefly for race and political meetings. In 1903–1904 no less than 13,719 instruments were dealt with from this service, and as most of these have to be issued and re-issued during the summer months it will be obvious that they have to be treated most expeditiously.

The whole of the apparatus supplied by manufacturers to the Department is submitted to most careful scrutiny to see that it corresponds with standard patterns and specifications. The failure to detect even small faults would lead to much trouble. This branch of the work is naturally becoming very extensive. During the last year some 150,000 instruments and 182,000 minor details were passed through the examining rooms.

The Department wires its own trunk-line switch sections and test-boards, local sections, and telegraph boards. The past year saw some 130 sections wired and passed out of the Holloway factory, whilst about 600 wall-boards of more or less complicated nature were also wired and despatched. This year the demands for this class of work are increasing. For the switching apparatus first remarked upon 30,000 jacks and plugs were made last year. To the work enumerated must be added the wiring of telegraph and repeating station sets, and the manufacture of thousands of lightning arresters, of the whole of the repairs to the London Pneumatic Tube system, and of constructional details for experimental work.

Some of the newest machinery has been introduced into the Holloway factory for screw-making, boring jack-sockets, and milling, and a very ingenious centrifugal oil-separator is at work which completely removes the oil from metal scrap collected at the various machines. This oil is filtered and subsequently used again. A very large saving has been thus effected.

Coming now to the general factory at Mount Pleasant, there is found an admirable equipment and trained staff designed to deal with a class of work largely different from that at Holloway. The extent of the operations can be realised by few who have not been through the factory, and some statistics are given further on which are calculated to illustrate the demands made by the postal telegraphs upon these workshops and the scope of the manufacturers. Although the component parts of cable boxes, batteries, and other articles of telegraphic equipments can be made with advantage by contract outside, still for assembly, and for examination, it is found to be in the interests of the public service that they should be collected at a central institution where they can be subjected to skilled scrutiny. It is found also that the preparation of woodwork for cabinets, switchboards, and test-boxes can be economically dealt with under the personal supervision of the technical staff. Regard-

ing the manufacture of electrical condensers, there has been a positive gain both in efficiency and in expense in confining the work to the Government factory, and the process is carried on with precautions which cannot anywhere be excelled. Indeed, it may be said broadly that this remark would apply to all the operations of both factories, which need not fear comparison with those of any in the world.

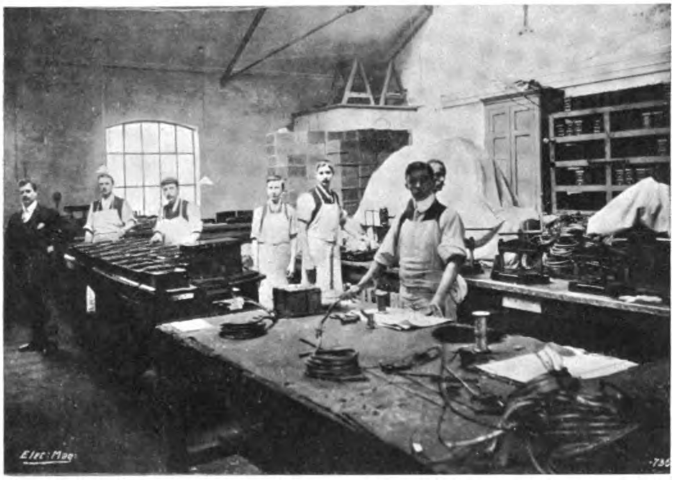
In the carpenters' shop some hundreds of silence-cabinets for telephones, telegraph and telephone switchboards, pole test-boxes, jointers' tents, cable guards, &c., are turned out every year. The wiring and jointing in the switchboards is of a very superior class, and the finished articles of the best seasoned walnut or mahogany, with their brilliant polish, are really handsome pieces of furniture. In the jointers' tents an improvement has been effected by the introduction of "duraline" windows, by which much needed light is admitted. The "duraline" is a transparent unbreakable material of a colour like church-window glass. The castings for manhole-frames and curves for street boxes are collected at Mount Pleasant, and the latter are fitted with stone to harmonise with pavements, or in carriage-ways with jarrah blocks. In the fitters' shop a large number of cable-connection boxes, distribution heads, iron cases for fuses and lightning arresters, cable-bearers for manholes, copper binders and tubes, desiccators for use with dry-air pumps for paper-cables, overhead structures for telephone wires, iron working patterns of joint-boxes, cast-iron bends, and couplings for underground work have been made of recent years. Immense stacks of oak and karri arms for telegraph poles are piled in the sheds behind the factory. These are shaped and delivered undrilled and unplaned, by outside contractors. Each is examined for flaws, gumholes, and irregular grain, in the factory. Those passed are put through the planing and drilling machines and are then dipped for forty-eight hours in compound. Great care is necessary in the examination of these arms, as they have to bear the weight of a linesman when erected, in addition to the wires, and an undetected flaw may lead to loss of life.

Some statistics of the work referred to in the preceding remarks are here given :

	Condensers. Microfarads.	Wall-boards.	Writing Desks.	Battery Boxes.	Arms.
1894–5	1,864	731	124	4,081	111,936
1895–6	647	926	311	8,358	88,225
1896–7	2,458	1,787	800	9,980	158,924
1897–8	1,991	1,035	500	383	115,244
1898–9	2,347	1,483	500	1,602	70,049
1899–0	3,514	1,618	613	3,306	100,581
1900–1	8,166	1,543	300	3,958	166,255
1901–2	3,841	2,344	516	8,460	217,113
1902–3	3,846	3,554	400	8,826	181,942
1903–4	12,324	3,026	1,130	7,295	154,293

For many years past the post office has used gutta-percha-covered cables for its underground work, but these are now being superseded by paper-covered lead-sheathed cables. Still, a great deal of the former type is still in use, and large quantities are sent into the factory for repair as well as for disposal when unfit for further use. The wire which is condemned is passed through suitable machinery, and the gutta-percha is stripped off the copper. The latter is sold, and the former is cleaned, rubbed up, and moulded into carrier-tubes for pneumatic pipes and into mouthpieces for street cable-ducts. From the good core, compound as well as single cables, are made up and covered with prepared tape for drawing in as required for the uuderground systems. A large amount of battery work is done in the factory of the Daniell, Leclanche, and Bichromate patterns The troughs of the former are repaired when sent in and new metals and porous partitions supplied, and in the case of the two latter the component

GUTTA-PERCHA WIRE SHOP.



Condenser Shop.

the country to be dealt with. Baskets and boxes for the parcel post are also repaired in large quantities, and, as indicated by the figures given below, show how steady is the growth of the parcel service. Some bicycle repairs have been done in this factory, but since October 1903, they have been performed by outside local contractors, as a matter of convenience.

This article cannot be concluded without referring to the officials who control and supervise the scientific and technical work of the factories. The whole of the work is, of course, immediately under the administration of Lord Stanley, the Postmaster-General, whose measures have been already productive of enlightened progress in the Post Office. Mr. J. W. Willmot, M.I.C.E., is Controller. Entering the service of the late Electric and International Telegraph Company in 1862, his transfer

parts, as received from contractors, are examined, treated with compound and paraffin where requisite, supplied with special terminals, and put together. The numbers of cables and batteries dealt with during the last ten years are as follows :

	Wire and Cable miles.	Leclanche Batteries.	Daniell Batteries.	Bichromate Batteries.
1894–5	2,626	74,596	46,828	15,911
1895–6	4,736	82,544	40,804	10,560
1896–7	2,806	98,022	46,054	14,310
1897–8	4,073	77,955	49,382	15,273
1898–9	3,790	78,100	49,182	16,269
1899–0	4,942	86,631	50,738	8,943
1900–1	5,509	71,651	47,932	4,414
1901–2	6,430	108,834	48,653	11,727
1902–3	3,232	92,811	43,585	9,198
1903–4	2,709	126,008	63,400	12,177

In addition, between September 5, 1900, and July 21, 1904, 52,310 joint-boxes were fitted.

The special ink used in the Morse, Wheatstone, and Hughes instruments all over the kingdom is made at this factory by special machinery, as also the peculiar gum with which the Hughes slip is fastened to the telegraph forms. The repair of leather mail-bags used in conveying mails by non-stopping trains is conducted here. These bags are thrown from the van and are subject to some very hard knocks. Other leatherwork made is the safety-belt used by linesmen when climbing poles. For packing purposes a dry cooperage is actively employed for casks, and another department is busy with cases, to enable the heavy consignments of stores for various parts of

	Repairs effected.		
	Parcel Post Baskets.	Parcels Post Boxes.	Bicycles.
1894–5	60,616	683	—
1895–6	49,202	52	—
1896–7	33,361	75	—
1897–8	72,746	1,529	—
1898–9	81,703	1,998	—
1899–0	83,550	3,136	259
1900–1	100,276	3,165	548
1901–2	109,706	3,080	1,167
1902–3	113,425	6,935	—
1903–4	37,984	3,029	—

to the Postal Telegraphs took place in January 1870, on the assumption by the State of the telegraph systems. He has thus served under Messrs. Latimer, Clark, Cromwell Varley, W. R. Cukey, and Sir William Preece. Mr. Willmot was made Controller of Factories in 1902 and his continuous service of forty-two years in the telegraphs thus peculiarly fits him to preside over the important institutions that have been described. He is besides an expert in pneumatic engineering, most of the apparatus in use until just recently being of his design, *i.e.*, the single and double sluice valves, and intermediate signaller. Mr. Willmot has also designed a great number of existing telegraph instruments and modifi-

cations thereof, and among his important devices may be mentioned the magnetic bias in lieu of the jockey roller in the high-speed Wheatstone transmitter, the hollow punch for perforators, and the pneumatic motion for the Hughes instrument. He also holds a Diploma of Honour from the Chicago Exhibition for skill as a designer.

At the general factory, Mount Pleasant, Mr. W. Bosomworth is Superintendent, Mr. W. A. Rylands and Mr. G. F. Mansbridge Assistant Superintendents, and Messrs. J. J. Clementson and C. W. Wheeler, Supervisors.

At the instrument factory, Mr. R. Britten is Superintendent, Mr. W. Milner, Assistant Superintendent, and Messrs. H. Moore and J. N. L. W. Brand, Supervisors.

In addition to the above, the establishment includes a principal clerk, three first-class, twelve second-class, and thirty third-class clerks, besides a number of boy clerks. There are also nine foremen, eight assistant foremen, storemen, and timekeepers, and the employés usually at work number over one thousand, including twenty-five females employed on light work such as lacquering and pneumatic carrier making.

The details necessary for composing this description of the factories have been furnished through the courtesy of Mr. Willmot, and these and the visit of inspection, made with his sanction and under the guidance of the Superintendents, the writer takes this opportunity of gratefully acknowledging. The photographs which accompany this article were kindly furnished by Messrs. C. Goldsmith and Company, of 20 Coborn Road, Bow, London, E.

A NEW MULTIPLEX TELEGRAPH.

A new system invented by J. J. Ghegan is described in the *Telegraph Age*, which comprises the use of an alternating source of current (preferably a dynamo) with the retention of ordinary keys, as well as of a continuous current devised from a battery. Two lines are required. The speed attained is not stated. In Fig. 1, G is an alternating current dynamo which supplies current to one pair of main line conductors in the multiplex combination shown, as well as the local artificial line circuit at the home station containing slightly modified polarised relays P′ P″ P‴, the tongues of which are thus caused by the alternating current to vibrate rapidly between their front and back contact points. It will be seen that these relays each possess an extra lever which engages with the normal tongue and is so arranged and adjusted as to vibrate in unison with its companion. Now, the duty of relay P′ is to divide the services of the direct current main line battery MB equally between the two sets of instruments marked Y′ and Y″

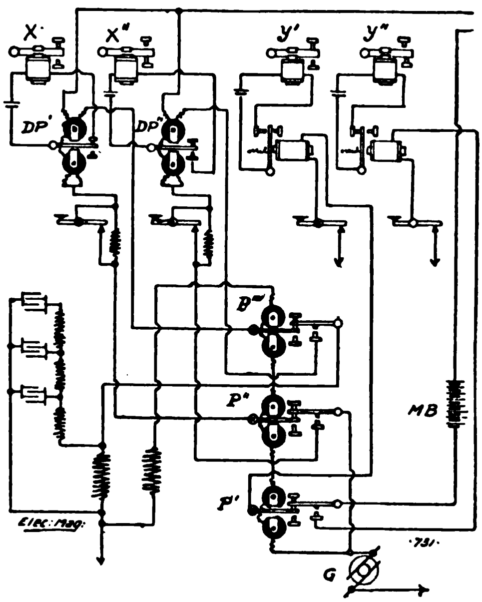


Fig. 1.

connected to its upper and lower contact points, respectively. On account of the rapidity of the vibrating lever the two circuits mentioned containing ordinary 150 ohm single line relays both receive a practically continuous current which, of course, magnetises and closes the relays in the usual manner. The sounders, however, remain open, as the local contact points are reversed as shown in the cut, until some one along the line opens a key and thus demagnetises the relay allowing the lever to fall back and close the local circuit.

In this manner an operator can, from one set of his instruments control all the instruments along the line which are in series with his own. Hence, if one set in each office is arranged to be in a temporary circuit when the alternating current sends the levers of all the polarised relays along the route, say, to the left, and the companions in circuit when on the right hand stop, two independent circuits with one actual conductor is the result. One wire carries the direct current between stations and the polarised relays in another circuit compel it to work double while passing through each office.

In like manner the alternating current itself, flowing through the lever of relay P″ to the two home circuits X′ and X″ and on to the next station, is compelled to work double and alternately energise two sets of instruments in each office. Thus the lever of relay P″ distributes current to all instruments in series with X′ and X″ while relay P′ performs a like service for those in series with Y′ and Y″.

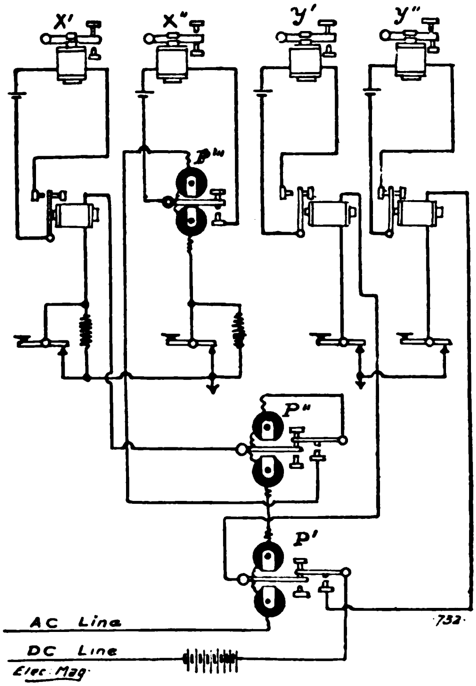


FIG. 2.

The receiving relays used in connection with X' and X" or alternating current circuit are differentially wound, but are not intended to be balanced to the line magnetically. The artificial line is introduced to balance the static discharge of the real line. The alternating current, after passing to the split in one or the other of the DP relays, according to the position of lever of relay P'", divides unequally between the main and artificial line, thus magnetising the relay; and because each half of the full electric wave is shifted from one set to the other each relay receives, say, all the postive impulses. and the other the negatives. thus providing each circuit with pulsatory or practically separate direct currents.

The relays DP' and DP" are then given a bias and otherwise so adjusted by means of a spring as not to close the local sounder circuits except when the normal current flowing through the line is weakened by the insertion of resistance which occurs when a key is opened. (*See* diagram.) In this respect the alternating current apparatus is actuated very much on the principle of a neutral relay of the standard quadruplex.

The duty of the polar relay P'" is to shift the artificial line from one coil of relay DP' to that of DP" at the expiration of each impulse and at the same time permit the condenser to discharge in the usual manner.

TELEGRAPH NOTES.

Type-printing Telegraphs.

THE use of type-printing systems is slowly being extended and appears to be limited only by the present unfamiliarity of operators with the peculiar features involved in the apparatus, as well as by a certain disinclination to abandon the Morse key. In America the Phelps, Buckingham, Rowland, and Hughes systems are in use to a small degree, in the United Kingdom, the Murray the Hughes and the Baudot, as well as the Exchange system, and on the Continent, the Hughes and the Baudot extensively. It would not be surprising if automatic systems of sending with type printed record became largely adopted for busy circuits within a few years.

Alaskan Telegraphs.

THE United States Government is about to lay a cable to connect Skagway with Valdez. The cable is of domestic manufacture and probably of india-rubbber insulation. It is not known whether cable communication will be extended beyond Valdez, or whether the Government will be content with the land line which extends from Valdez to Dawson, and from Dawson to St. Michael. The severe winter renders both forms of communication difficult to maintain, but General Greely is doing his best. From Eagle, near Dawson, to Valdez, a distance of about 400 miles, the line follows the Government trail. This part was particularly hard to instal, but the line down the Tanana was even more so. It was necessary to string the wires along the surface of the deep snow in the winter and elevate them to poles in the summer, for the ground in many places is so soft when the sun melts the snow that travel over it is most difficult. Then the long stretch down the Yukon to St. Michael—about 800 miles—was a sore drain on the energies and resources of the signal service parties detailed to the arduous duty.

Keeping the lines up through the wild country, where storms rage and perils of all sorts threaten, is no easy task, for hundreds of miles of wires have been prostrated at a time, and parts of the line have been down weeks and months at a time, just when it seemed all was complete. A fierce forest fire in the Tanana Valley burned down thousands of newly erected poles when the signal service was ready to announce the completion of the land system. Within a few months it is hoped to have wireless communication across Nortun Sound, 115 miles, between St. Michael and Nome. Several attempts have been made and failed.

Fire-Alarms.

ELECTRICAL systems for the protection of towns from the effects of fires have been of great growth in the United States. A summary of statistics of increase is reproduced by the *Telegraph Age* and the figures are very remarkable. In 1903 there was a total of 764 municipal electric fire-alarm systems. These systems had in the aggregate a total overhead wire mileage of 28,202 miles, besides 11,433 miles of wire in underground conduits. The earliest

records dealing with the subject show that fire-alarms and fire-extinction were matters which until the last century were left largely to private or volunteer effort; now, however, the 764 systems included in the statistics are under the supervision of some department of the various city administrations. From 1852 to 1862 only four systems of fire-alarm telegraph were installed. In the next ten years forty systems were put in. From 1872 to 1882 the increased appreciation and demand on the part of the public were shown by the installation of sixty-two systems. The rate of increase was well maintained from 1882 to 1892, during which period 299 systems were installed. In the eleven years from 1892 to 1902 inclusive, the number of new systems was proportionally greater, reaching 359. In view of the fact that all the larger cities had already been equipped, the swelling number would indicate that as time has gone by the improvements of the system and the increasing introduction of automatic features have rendered the service available for many of the smaller communities. Distributed along the circuits of the 764 systems in the United States there were reported 37,739 signalling boxes or stations. To this number might be added 1,900 special telephones and ninety-three annunciating boxes. Over this apparatus 85,070 fire-alarms are reported to have been sent or received during the year 1902.

Electrical Transmission of Photographs by Telegraph Wire.

THE ingenious method of Professor Korn of Munich has been described in the *Physikalische Zeitschrift*, this year and may be summarised briefly as follows: By means of a lens and a source of light a selenium cell placed within a glass cylinder, and in circuit with a battery is caused to vary in resistance as the light falls upon it through the photographic film wrapped on the cylinder. According to the tones of the film as it is rotated so will the light vary, and the consequent variation in the current passing through the selenium cell is made use of at the other end of the line to move the indicator of a galvanometer. This indicator operates the arm of a rheostat in a Tesla Coil Circuit and permits of the light from an exhausted tube to affect a sensitised film which is revolved synchronously with that at the station of origin.

Synchronism of the cylinders is obtained in the following manner: The motors, being shunt machines, have a natural tendency to run at a fairly uniform speed. The source of current being accumulators, the speed of the motors, particularly when running without load, as is approximately true with these machines, can be kept constant within one-quarter of 1 per cent. without difficulty. Variation of speed resulting from changes of temperature are adjusted according to the indications of a Hartmann frequency indicator by regulating the shunt circuit resistance.

In half an hour a portrait of a size 12 × 16 cm. used in the transmitting station was reproduced in the receiver in a size 3 × 4 cm. When handwriting or drawings are to be transmitted they are executed with non-conducting ink on metal foil wrapped on a cylinder. A metal pin is passed over the metallic surface and both form part of the circuit. The current is interrupted when the pin crosses the ink and thus the receiving film can be impressed with dots. By this method and by substituting a rotary for the galvanometer, a speed of 500 words per hour can be realised. Photographs have been successfully transmitted over a four-fold line between Munich and Nurmberg, the resistance of the complete loop being 3,200 ohms.

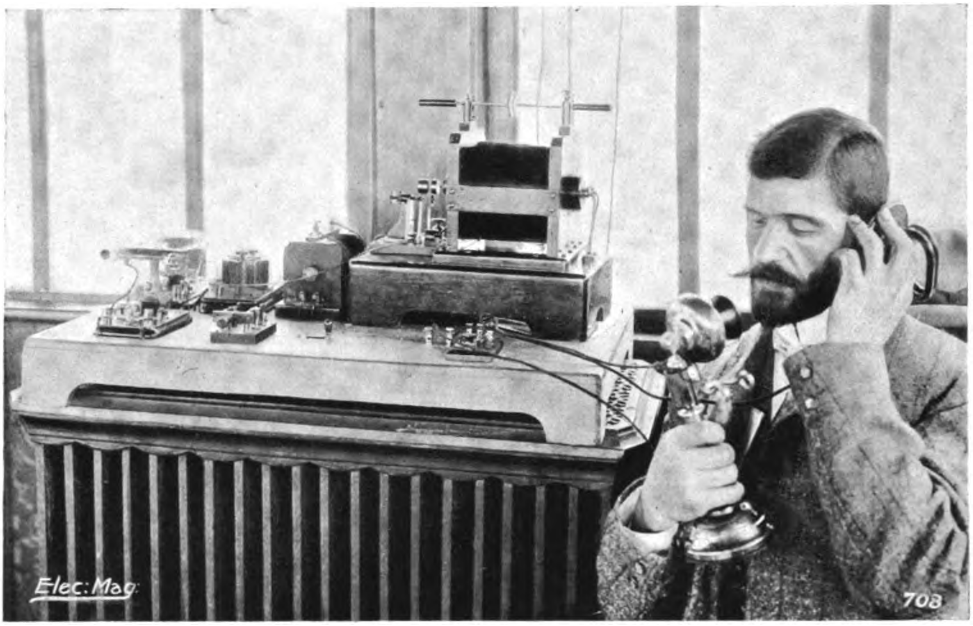
Telephony.

WIRELESS TELEPHONE SYSTEMS.

By FRANK C. PERKINS.

SINCE wireless telegraphy has been brought into extensive use for marine work on both oceans and lakes for naval and commercial purposes there has been great interest taken in developing a successful wireless telephone system. In the navy as well as in the merchant marine it would be of the utmost importance to be able to talk personally with the commanders of the various ships and remain in constant communication with these officials at all times regardless of the weather. The accompanying illustrations show the apparatus employed by American and German engineers for wireless telephone systems as worked out by A. Frederick Collins, and placed on the market by the Collins Marine Wireless Telephone Co., and Mr. Ernst Ruhmer of Berlin, which is being installed by the Siemens-Schuckert Werke of Germany.

The American system of Mr. Collins was tested at Rockland Lake, New York, and also on the North River between Jersey City and New York, the test of wireless telephony being also made between moving ferry-boats on the Hudson River. The experiments conducted with this apparatus at Congress resulted in the hearing of articulate speech distinctly over a distance of more than a mile, while in the harbour where the conditions were somewhat different the distance covered was about 1,000 feet. The apparatus noted in the illustration is arranged to send and receive telephone messages with calling and indicating appliances as used in the ordinary telephone service. The wireless telephone system is in the nature of a combination of the ordinary telephonic apparatus and wireless telegraph apparatus. In an interesting paper on the wireless system of A. Frederick Collins by Dr. T. Byard Collins, he says, "The experimental researches of Mr. Collins in seeking the best means for the transmission of speech without wires are interesting, since he began with the conductivity and has run the whole gamut up to the Hertzian wave method. In this way he became familiar with the merits and limitations of all the different means to the end



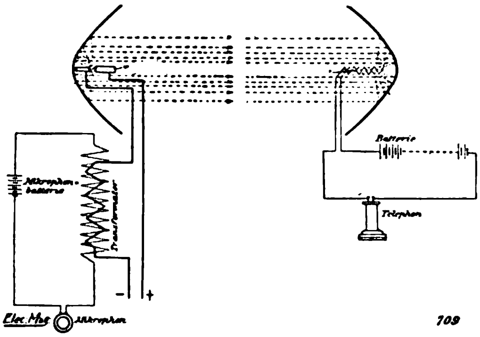
WIRELESS TELEPHONE IN USE ON FERRY-BOAT.

of wireless telephony. In his investigation of Hertzian wave phenomena he slowed down the high-frequency oscillations until they registered a periodicity of only a thousand per second, when the emitted waves were of correspondingly greater length, so long in fact, that it was indeed difficult to determine whether they were transverse vibrations in the ether or longitudinal current thrusts. In producing these phenomena Mr. Collins damped down the oscillator circuit by the addition of capacity, using a battery of Leyden jars for the purpose and sustaining the relation of the coefficients by adding inductance formed of coils of fine wire ; as the frequency of oscillation slowed down to a period equal to mechanical vibration, the telephone receiver responded and without the intervention of a coherer or other wave-detecting device, and the period of alternation at which it operated the best was between one and two thousand. In these experiments a closed circuit oscillator and resonator was employed so that the oscillations would be rendered as persistent as possible ; now what with the damping factor, the low-frequency and the closed circuit, it is evident that distance would not be bridged to any great extent, yet sufficient to show that there was a germ for a system of wireless telephony which, properly clutured, would be of service for places where a few thousand feet would suffice."

The Collins Wireless Telephone system was successfully tried on the ferry-boats of the Erie Railroad, the " Ridgewood " and the " John S. McCullough," and they were able to communicate with each other in midstream while going in opposite directions. These experiments, it is claimed, proved not only the possibility of sending speech without wires but also its commercial value.

The German wireless telephone apparatus has now been brought to such a state of perfection that it is being constructed and installed by the Siemens-Schuckert Werke of Berlin, Germany. The accompanying illustrations show the Ruhmer apparatus for telephoning without wires by the aid of electric projectors. The new German wireless telephonic apparatus is the result of the recent research of Prof. Simon, of Goettingen, and Mr. Ernst Ruhmer of Berlin. It is now possible to telephone to a distance

FERRY-BOATS FITTED WITH WIRELESS TELEPHONES.



CONNECTIONS FOR SPEAKING ARC LIGHT TELEPHONES.

of ten miles without wires by the use of the searchlight and selenium cells of the Ruhmer type. The speaking arc light used in the projector or searchlight may be operated at from 2 to 4 amperes in clear weather, and from that up to 10 amperes when the weather is less favourable. The carbons have a diameter of 6 and 9 mm. and the pressure is as high as 220 volts. The arc lamp is in the focus of a mirror, .45 meter in diameter of the parabolic type, and is connected in series with one of the coils in such a manner that the speaking into the carbon transmitter superimposes waves on the arc circuit. In series with the fine wire coil and the carbon transmitter is the microphone battery. At the receiving station a similar parabolic reflector is provided, having also a diameter of .45 meter, in the focus of which are the Ruhmer selenium cells connected in series, with a storage battery of from 20 to 35 cells, giving a tension of 40 to 80 volts, and in series with an ordinary telephone receiver. The current in this circuit varies from 20 to 30 milliamperes. The apparatus constructed at the Siemens-Schuckert Werke, in Berlin, is very light and transportable, and will find extensive use both commercially and in the Army and Navy. There is also an interesting field of utility in connection with lighthouses where signals may be

ARC LIGHT TELEPHONE IN USE.

supplemented by actual conversation with officers in charge of steamers and vessels. This will be of practical value not only for ordinary messages but also in time of danger, when a detailed warning may be given noting the special dangers to be guarded against by the vessel in communication with the lighthouse. The ease with which the receiving apparatus may be moved about makes it of equal value on land where special messages are to be sent to a number of stations temporarily, which would not permit of a telephone line being instilled for the purpose or for so short a time. A great many uses for this valuable addition to modern telephony could be mentioned, and there is no question but what, in a very short time, the system will be extensively employed.

The latest experiments of 1903 and 1904 have shown that wireless telephony is entirely successful at a distance of 15 kilometres. The great receiving station employed for these successful experiments, was equipped with a glass parabolic mirror of 80 cm. aperture. The double station for sending and receiving is equipped with a Schuckert searchlight of special construction, having an aperture of 35 cm. Also an accumulator battery and receiving apparatus for registering Heliographic signs in Morse-form.

Wireless Telegraphy.

SYNTHETIC WIRELESS TELEGRAPHY.

By L. H. WALTER, M.A., A.M.I.C.E.

IT must have occurred to many of those interested in the subject, what an excellent system of wireless telegraphy could be built up were there no such thing as patent rights to be considered, and were one free to take the most desirable and effective feature or features out of the various different existing systems and blend them into a harmonious whole, giving a system of the highest possible excellence as far as the present state of knowledge of the subject goes. Mr. A. Frederick Collins, in a recent article in the *Electrical World and Engineer*, has given expression to his ideas on such a synthesis, going a step further even in taking some features from the ideas set forth in various United States patents on the subject of wireless telegraphy, although he observes that an inspection of the majority of such patents reveals that they are "paper" inventions designed to, if possible, cut away the ground from future improvements.

In considering the existing commercial systems he boldly points out that in each of these practically the special claim to its being *the* best hangs upon one special feature

which, in itself, may be almost unapproachable, but the mean value of the complete system is lowered by the other constituent parts which are often very far below the average of such devices in another system. He then proceeds to select those special features from the well-known systems, which he considers to be the most perfect of their kind, and to combine them into a system which should give (1) a maximum distance with minimum energy; (2) accuracy; (3) speed; (4) certainty of operation; (5) simplicity of adjustment, and (6) a commercial apparatus satisfying the demands of the users. For the transmitter he selects the de Forest oil-break Morse key, the high-frequency currents being produced by Fleming's method of employing an alternator in place of a direct-current generator. The pressure is stepped up by oil transformers provided with choking coils and sheet-metal screens to prevent the high-frequency currents from flowing back into the transformer coils (de Forest). The spark-gap in highly compressed air (Fessenden), and the oscillation transformer and variable capacity of Braun complete the essential apparatus.

For the ideal receiver—which he considers should possess, besides the before-mentioned considerations, simplicity of adjustment and give a written record of the message—there is more wavering in his decision as to which features completely supply the want. For a written message either the Morse inker or the siphon recorder is needed, for which the Slaby-Arco and Lodge-Muirhead systems respectively employ their coherers; but the latter is held to be unsatisfactory owing to the alteration in resistance and the need for adjustment. Two alternatives are therefore offered; (1) the use of the liquid baretter (Fessenden) with the siphon recorder, the latter requiring kid-glove treatment, or (2) the baretter with telephonic reception; but the former is considered preferable. The complete combination is considered to be what one could expect were a great Wireless Trust to be effected, comprising all the existing systems.

Although a system made up of the different elements chosen by Mr. Collins would doubtless give a good account of itself, it is not easy to see why some of the features have been selected to the exclusion of others. Without in any way detracting from the interest of Mr. Collins' paper, the choice of the spark-gap is one which might be challenged. The theoretical promise of the compressed air spark-gap is excellent, but no record is available that it has ever been used or is being used, whilst the Cooper Hewitt mercury vapour gap, on the other hand, has been shown by several investigators to have advantages which seem to outweigh those possessed by the compressed air-gap. As regards the choice of apparatus for the receiver the selection of the Slaby-Arco coherer is another debatable point. This was chosen by the United States Naval authorities after test, but the Marconi coherer has achieved a much larger measure of success and is regarded as the coherer "par excellence." Besides the reason for the United States Naval choice was financial and not electrical, as is well known. For use with the siphon recorder the baretter would seem very desirable, if, as has been stated, the resistance variation is sufficient to work it, though if such is the case the de Forest or Schloemilch electrolytic detector, or rather the Pupin asymmetric cell—for that is what these really are—would be equally good. For telephonic reception, however, it is difficult to understand why the Marconi magnetic detector was not selected. This has given results as a receiver, which have not yet been beaten by any other, in spite of some measurements, not as yet independently corroborated, that its sentiveness is comparatively small compared with certain other liquid detectors. Finally, some other features, which it would be a pity to leave out of an *ideal* system, might be referred to. Firstly, the ionising of the spark-gap (de Forest), by means of which the main circuit need have no interrupting key, and the device of Braun, for increasing the transmitter energy (radiated) without increasing the size of generating plant; (2) the arrangements (Stone) for emitting an undamped train of pure sine-waves, and for imparting directive quality to the waves (Artom); (3) in receiving, the linked circuit weeding-out system (Stone, Ehret) and the directed receiver (receiving only from a definite direction) (Stone), and, lastly (4) the telegraphonic method of Reich, by which, besides being able to work at the speed of telephonic reception, a record is provided, though only an audible one.

TUNING BY A NEW METHOD.

Yet another of the ingenious devices of Prof. Fessenden is described in a British patent recently granted to him for Improvements in Wireless Telegraphy. The object in this case is to arrange matters so that a number of stations situated very near to one another can be worked simultaneously. Such an object is usually sought to be attained by means of some form of syntonic arrangement, but this, as is well known, will not hinder a neighbouring station from being affected, even when not in tune. In the present instance the signals are produced by a variation in the periodicity of the oscillations while their intensity is kept constant.

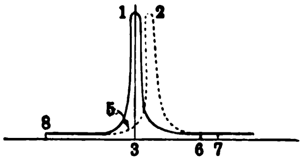


Fig. 1.

Fig. 2.

Elec. Mag. Fig 3 774

The way in which this produces the desired result can be seen from Fig. 1, in which two resonant curves are shown—8, 1, 6 in full lines and 8, 2, 7 in dotted lines. If a station is in tune with the full-lined curve the intensity of the received impulse will be represented by the ordinate at 3 to the line having frequencies as abscissæ; but if the frequency be changed while the intensity at the transmitter is kept constant, the point of maximum resonance will be displaced to the point 2, and the intensity at the receiving station will only be that represented by the ordinates to the dotted curve.

Supposing that there were a station near by, tuned to a frequency 6, then, when the displacement of maximum resonance from 1 to 2 occurs, the effect on such a station will only be from that represented by the ordinate 6 to that represented by 7; the difference is practically negligible, and so is the effect on the near-by station. The effect produced by two interfering stations, one tuned and the other operated in the usual way—by changing the intensity—is depicted in Fig. 2. Here the shaded parts represent the effects produced at the receiving station when a tuned station sends the letter D, and the other the letter K. The two effects being superimposed the signal is unintelligible. In Fig. 3 is shown the effect produced when the frequency is changed and not the intensity, according to this method. Here also the shaded parts represent the effects produced at the receiving station by a tuned transmitter station, while the unshaded portion represents the effect produced by a near-by station signaling by changing the frequency but not the intensity. It will be seen that no disturbing effect is produced, the signal being quite legible. (The shaded parts are simply superposed on the steady state caused by the continuous radiation.) Two methods of changing the frequency are illustrated diagrammatically in Figs. 4 and 5. In the first, on depressing the key e, the frequency will be changed, the intensity being only very slightly altered. In the second the depression of the key changes the period in both the closed oscillatory circuit b[1] d h and in the antenna attached, suitable values for the short-circuited inductances being determined by experiment or by previous calculation. Should the method work in practice as well as it appears to theoretically, it should be of considerable value, as it is a distinct advance on pure syntonic methods, and at the same time is free from the complications of mechanical syntony. From an operating standpoint the continuous emission of waves will be somewhat more costly than the usual method.

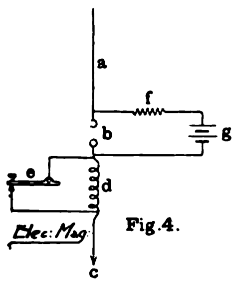


Fig. 4.

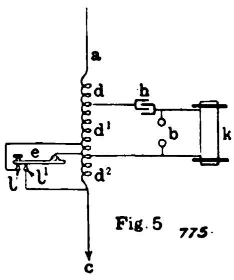


Fig. 5 775

WIRELESS TELEGRAPH NOTES.

The Wireless Telegraphy Bill.

This Bill, which was referred to in our last issue, has now been passed in practically the form of the draft Bill, and is already being put in force.. The attitude of Lord Selborne, in giving expression to the views of the Government on the subject, is interesting as confirming our correspondent's statement as to the helpless feeling which prompted the Bill. The chief satisfaction that will be felt by the general public is that owing to its comparatively early appearance, the Bill will prevent the growth of yet another set of vested rights which would have to be bought out later at enormous cost; for the taxpayer, ever threatened with new possible demands on his purse, this is some comfort.

A Reasonable Suggestion.

In *Electricity*, of New York, recently there appeared a powerful editorial in which it is urged that the equipment of vessels with wireless apparatus, especially such vessels as are intended for excursion traffic, should be compulsory. The only cause operating at present against such equipment being undertaken voluntarily, is that of expense. Although the article was written just at the time when public opinion was inflamed by the disclosures resulting from the *General Slocum* holocaust, it is quite possible that if attention were paid to this particular branch of the business, that such

vessels could be supplied with a much simpler, less powerful and very cheap apparatus, good for about thirty miles, which need only be fitted for automatic codal distress signals, for instance (so that wireless companies would not require heavy royalties as in the case of messages). For the Bay of New York, owing to the comparatively short distances, there seems to be a good opening for such an enterprise.

An Important Naval Contract.

A MOST important contract was recently concluded between the United States Naval Bureau of Equipment and the de Forest Wireless Telegraph Company, under which the latter are to construct, or rather equip (for the construction will be carried out by the Navy Department), some large wireless stations to be situated at Cuba, Porto Rico, Panama Canal coaling-station, Key West, Dry Portugas, and Pensacola, the distances to be dealt with ranging from 350 to 800 miles. Thus long-distance wireless communication is contemplated for commercial purposes by the United States Government, the stations being also of great strategical value in case of war. The most difficult line is held to be that from Cuba to Porto Rico, 450 miles, in which the mountainous island of Hayti, which lies directly in the line, has to be traversed. The most important one is probably that between Panama and Guantanamo, needed in connection with the Panama Canal operations. The stations are expected to be working in seven months.

Noiseless Music by Wireless.

IN the *Western Electrician* an account of the wireless telephone installation (which is without wires, but not wireless in the accepted sense of the word) at the Palace of Electricity at the St. Louis Exposition is given. The system is that of Mr. Hutchison, and though not very clearly described it appears that there is a special transmitter of the microphonic type, but capable of taking a current of 15 amperes, being for this purpose provided with water-cooling arrangements. A large graphophone plays into this transmitter, and a large coil connected to the latter is buried in the ground. Any one walking in the court hears nothing, of course, in the ordinary manner, but on being provided with an inductor coil connected to a pair of telephones, the music discoursed by the graphophone can be heard whilst walking about anywhere in the neighbourhood. The reproduction is stated to be satisfactory and to diminish the harshness of the graphophone itself. The experiments have shown that the effect can be obtained over an area of several acres.

Service Suspensions.

REFERRING to the Marconi wireless station on the Nantucket Lightship, the operation of which was suspended, as was announced in our columns, the cause was given as "refusal to receive communications from ships fitted with other systems." The *Daily Telegraph's* New York correspondent, however, says that a letter was written by the German Ambassador to the United States to the Secretary of State, on the subject of German vessels being precluded from communicating; and it is as a result of this that the station's operation was suspended. Imagine the British Ambassador taking up the cudgels on behalf of a British industrial company, and seeking to extend their commercial field by political interference! Not that Britishers would like such interference; but it shows to what extent the foreigner is backed up in his trade, even outside his own country. The Marconi station at Siasconset, Mass., is now likewise to be suspended, according to the *Electrical World*, and it is believed that United States Government stations, using their own system, will be installed instead, and also at the South Shoals Lightship.

The Rochefort System.

MR. A. FREDERICK COLLINS describes the Rochefort system of wireless telegraphy in a recent issue of the *Electrical World*. As is known, the coil used is of Rochefort's unipolar type, so called since one pole of the secondary has only a very low tension, the tension at the other pole being considerably increased. This result is attained by a double winding of the secondary wire, so that it returns and is joined to the pole from which it starts, the neutral pole connection being taken from the centre of the wire. The principle and mode of using the Oudin resonator are described, the resonator having been chosen for syntonic purposes in this system, but the latest method of connecting the double resonator is unfortunately omitted. The apparatus used is illustrated, also the coherers used—that of Tissot and the magnetic one of Rochefort, in which the lines due to a magnet are caused to help coherence, when produced, by their attractive influence on the filings. It will be remembered that the Rochefort system is used by the Brighton Railway Company for communicating between Newhaven and Dieppe.

Danger Signal Device.

IN connection with the article in *Electricity* of New York, referred to above, a device of de Forest's, for wireless danger-signalling for ships, is of interest. By this method it is proposed to produce a variation in the sound at a receiver station by altering the frequency of the oscillations, which alterations may be of such chosen number and duration as is desired, the frequency being, for instance, altered by altering the distance between the balls of the spark-gap. The receiving apparatus is preferably of the self-restoring type combined with an indicator which will produce an audible sound when the variations in frequency take place. By the use of such a method fitted on ships, and with coast stations fitted, to each of which a distinctive signal could be given, the vessels would, on coming within the radius of influence, at once know by the sound indicator that they were close to such and such a station. The method can also be used for giving warning of the approach of two vessels towards each other, which would be of great value in case of fog, a previously agreed upon set of signals enabling a safe course to be chosen by each vessel.

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section at end of Magazine.

Electro-Physics at the British Association.

By G. W. DE TUNZELMANN, B.Sc., M.I.E.E.

The Presidential Address of the Prime Minister must have come as a great surprise to the many who know him only as the busy man of affairs responsible for the government of a world-wide empire. To all those who are convinced of the importance of systematic reasoned knowledge, otherwise called science, to the upward progress of man it cannot be other than a great encouragement to find that the steersman of the ship of state is so fully imbued with this truth that he has found time, amid the multifarious cares inherent to his office, to keep himself abreast of the most recent results of research into the physical realities underlying the phenomena apparent to the ordinary superficial observer, and not only to make himself acquainted with the results, but to devote long and careful consideration to their correlation into a connected scheme of thought. The whole address is a broad and lucid exposition of the electrical theory of matter. Those ill-informed persons who love to speak of electricity as being in its infancy may be recommended to read, mark, learn, and inwardly digest Mr. Balfour's statement of the case. Great will be their astonishment to learn that the infant which some two hundred years ago was nothing more to the natural philosopher of that day than the hidden cause of an insignificant phenomenon, is now regarded by many of those most competent to form an opinion as the true physical basis of the whole material universe. In its eloquence the address rivals the famous Belfast address of the late Professor Tyndall, but there the resemblance ends. The keynote of Professor Tyndall's address was the most uncompromising materialism; it is the idealistic interpretation of the universe which forms the dominant chord in Mr. Balfour's. Very interesting trains of thought are aroused by the reflections on the instinctive craving after unification which has led to so many discoveries and generalisations by the philosophers of the West, and which has been put forward with even greater insistence, though from a totally different point of view, in some of the ancient philosophies of the East.

The first electrophysical paper was read by Professor H. Rubens of Charlottenburg, and dealt with the ultra-red rays of very great wave-length which he has succeeded in obtaining by means of repeated reflections of light from polished surfaces. He found that these long waves gave results in agreement with Maxwell's relation between reflecting power and conductivity, a result of very considerable theoretical importance, as this relation had not hitherto been confined by experimental results.

A discussion on the N-rays was opened by Dr. Lummer of Charlottenburg. He and other German physicists present, freely expressed their scepticism of the objective reality of the results obtained by Blondlot and other French physicists, inclining to the belief that the alleged phenomena were mainly physiological, if not psychological. Professor Schuster described his investigations dealing with the ionisation of the atmosphere. The rate of ionisation is found to be much the same in towns as in air confined in closed vessels, and greater than in the pure air at considerable altitudes, although the actual proportion of free ions is usually greater in the latter case.

A discussion on the radioactivity of ordinary matter was then opened by Prof. J. J. Thomson. He showed good grounds for believing that radioactivity is, to a greater or less extent, an inherent property of every kind of matter. This is what

would be anticipated if the electrical theory of matter is a true one.

Professor Fleming read a paper on Electric Waves along Spiral Wires and on an Appliance for Measuring the Length of the Waves used in Wireless Telegraphy.

A helix is dielectrically coupled with an independent oscillator circuit with a spark-gap fed by an induction coil. The wave-length of the oscillator vibration is then measured by isolating a complete wave on the helix by means of a sliding earthed saddle. By using a Neon vacuum tube as the indicator, the author was enabled to give a brilliant demonstration in full daylight.

The inductance and capacity of the oscillator having been determined by previous measurements, the inductance of a coil of wire can be determined by inserting it in the oscillator circuit, and noting its effect on the length of the isolated wave in the helix. An inductance as small as that of a yard of wire arranged in a few loose turns can be determined in this manner.

ELECTRO-PHYSICAL NOTES.

On a Radioactive Gas Derived from Raw Petroleum.

FRESH raw petroleum, as shown by E. F. Burton's experiments (see *Physikal Zeitschrift*) contains a strongly radioactive gas, resembling by its rate of decay as well as by the rate of decay of its excited radioactivity, the emanation of radium as well as the emanation produced by some experimenters from mercury and from certain waters freshly derived from the ground. This radioactive gas will decay approximately according to a potential law, the half-value being reached in 3.125 days. It will excite and induce radioactivity of a rate of decay, such as to fall to the half-value in about 35 min. Raw petroleum seems to contain small traces of a radioactive substance more permanent than radium emanation.

Photoelectric Fatigue and Photometry.

A NUMBER of investigations made since the discovery of the so-called photoelectric fatigue (being a gradual decrease in the photoelectric sensitiveness) is reviewed in a paper by W. Hallwachs, published in *Physikalische Zeitschrift*. It is shown that the photoelectric fatigue, with almost absolute certainty, is to its greater part due to ozone, while light radiations under ordinary conditions do not constitute a primary cause of fatigue. Secondary effects of light are, however, observed for instance, in the case of the mercury lamp on account of the formation of ozone due to light. Other secondary fatiguing effects are for instance produced by water vapour. The author incidentally shows that arc lamps may be made to give off ultra violet radiations of relatively high intensity and of a constancy superior to what had hitherto been supposed, so as to be available for photoelectric measurements.

On the Distribution of Spectral Energy in the Quartz Glass Mercury Lamp.

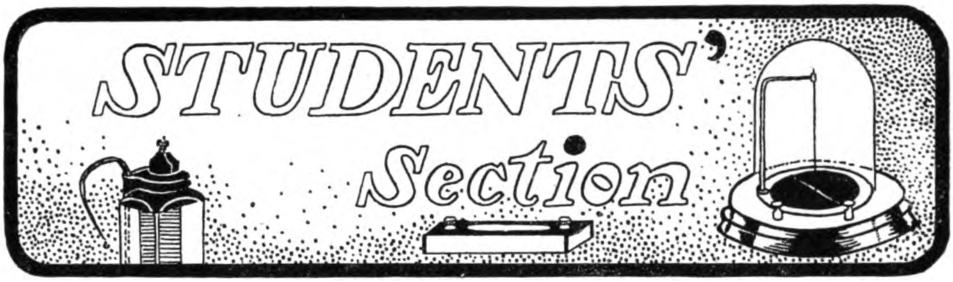
THERMIC batteries have first been used with some success by Hagen and Rubens in connection with energy measurements in the ultra-violet part of the spectrum. The range of availability of thermic cells was shown by Pflüger to go up to 185 $\mu\mu$. (Ann. der Physik. 13 p. 8190 1904.) In a paper by E. Ladenburg published in the *Physikalische Zeitschrift*, thermic cells are used for ascertaining the distribution of energy in the spectrum from quartz mercury lamps such as have recently been constructed by C. Heraeus. The lamp was placed in a light tight zinc casing fitted with a narrow slot, the slot tube of the spectrometer being placed immediately before the latter. The spectrometer was provided with quartz-fluor spar achromates and with a device for automatical minimum adjustment. The thermo-currents were measured by means of a Du-Bois-Rubens armour galvanometer.

The Distillation of Zinc in Electric Radiation Furnaces.

A PROCESS for the distillation of zinc in electric furnaces has been patented by Mr. G. de Laval (*Elektrotechnische Rundschau*). This process consists of mixing finely divided zinc ore with coal reduced to a fine powder, iron ore, limestone, &c. After this mixture has been prepared with every possible care in the dry condition, it can be moistened if desired, so as to avoid the production of dust. This mixture is afterwards introduced into an electric radiation furnace, so that the surface turned towards the source of electric heat, under the action of the radiating heat, is soon brought to so high a temperature that the zinc as well as the other metals present in the ore, as for instance lead, gold, silver, &c., whose point of vaporisation is reached, are soon vaporised, melting the remainder of the charge, which flowing downward is further submitted to the heat from the thermic source, slags and any non-vaporised metals being deposited. The escaping metallic vapours are condensed conveniently and the condensed product is further treated with a view to recovering for instance ingot zinc.

On the Radioactive Emanation Contained in Spring Waters.

SPRING waters have been shown by J. J. Thompson and F. Himstedt to contain a radioactive emanation, being removed either by boiling or by allowing air to bubble through it. The emanation found by Elster and Geitel in the free atmosphere and, to a great extent, in the capillary tubes of the soil, seems to be identical with the emanation in spring waters, their common origin being a radioactive substance occurring both in air and water, and susceptible of giving off an emanation. As pointed out by H. Mache in a paper recently published, a careful investigation of the properties of this active substance will show whether this is really a new radioactive body or one of the already known active substances. These experiments show that most, if not all, of the spring waters examined really contain radium emanation.



Students should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles of special interest to them.

Some Illustrations of Approximate Methods of Solving Problems —IV.

By ALFRED HAY, D.Sc., M.I.E.E.

(*Continued from p.* 172.)

SECOND *INTERVAL.* — We assume, as a first approximation, that the rates of change of the currents I and i in the two sections of the line remain unaltered during the second interval, and since we have already found that $I_1 = 16.46$, $i_1 = .134$, this is equivalent to assuming (provisionally) $I_2 = 32.92$, and $i_2 = .268$. Using the equations,

$$v_{n+1} = v_n + 50\,(i_{n+1} + i_n) \quad . \; . \; . \quad (13)$$
$$V_{n+1} = V_n + 50[(I_{n+1} + I_n) - (i_{n+1} + i_n) \quad . \; . \quad (11).$$

in which we now put $n = 2$, $v_1 = 6.7$, $i_1 = .134$, $i_2 = .268$, $V_1 = 816$, $I_1 = 16.46$, $I_2 = 32.92$, we obtain $v_2 = 26.8$, $V_2 = 3265$. Substituting these values in the equations

$$I_{n+1} = 16.6 + .99\, I_n - .000166\,(V_n + V_{n+1}) \quad (10)$$
$$i_{n+1} = .99\, i_n + .000166\,(V_n + V_{n+1} - v_n - v_{n+1}) (12)$$

we obtain $I_2 = 16.6 + 16.29 - .67 = 32.22$, and $i_2 = .133 + .672 = .805$. Using these more accurate values of I_2 and i_2, and substituting in (13) and (11), we find $v_2 = 53.6$, $V_2 = 3230$. This completes the second approximation. We now proceed to the third approximation, which consists in using the values just obtained for v_2 and V_2 in equations (10) and (12), so as to obtain new values for I_2 and i_2, and then using these latter in equations (11) and (13) for redetermining V_2 and v_2. The new values so obtained are :

$I_2 = 32.22$; $i_2 = .794$; $V_2 = 3204$; $v_2 = 53$.

No further approximation is necessary, as it will be found on trial that the last set of values is practically reproduced.

Third Interval.—We might proceed as before, assuming provisionally that the current increments $I_3 - I_2$ and $i_3 - i_2$ are equal to $I_2 - I_1$ and $i_2 - i_1$ respectively, and then, using equations (10) to (13), obtain a series of approximations of an increasing degree of accuracy.

The following alternative method will, however, be found to yield accurate values more quickly. Referring to the values of the currents already obtained, we notice that the current increment $I_1 - I_0 = 16.46$, while the increment $I_2 - I_1 = 15.76$. From this it appears that the current increment is *decreasing*, and that its decrease from the first to the second interval amounts to $16.46 - 15.76 = .7$. We shall provisionally assume that the same decrease occurs in the current increment during the third interval, so that the increment $I_3 - I_2 = 15.76 - .7 = 15.06$. This gives for the first rough value of I_3, $32.22 + 15.06 = 47.28$. Similarly, the current increment $i_1 - i_0 = .134$, while the increment $i_2 - i_1 = .66$. From this it is evident that the current increment for i is *increasing*, the increase from the first to the second interval amounting to $.66 - .134 = .526$. We shall assume that the same increase in the increment occurs during the third interval, so that $i_3 - i_2 = .66 + .526 = 1.186$, and hence $i_3 = 1.98$.

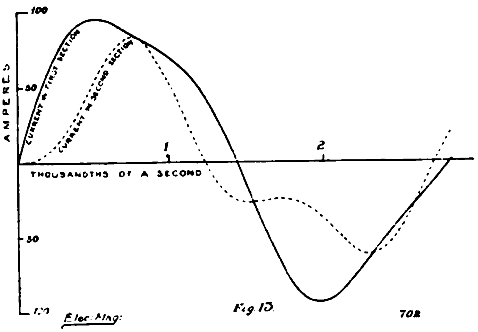
We now use the provisionally adopted values $I_3 = 47.28$, $i_3 = 1.98$, for obtaining first approximations to V_3 and v_3 by means of equations (11) and (13), and so complete our first set of approximate values. We thus find $V_3 = 7040$; $v_3 = 191$.

Everything then proceeds as before, a second approximation being obtained by means of the four equations (10) to (13). The values given by the second approximation will be found to be : $I_3 = 46.8$; $i_3 = 2.45$; $V_3 = 6993$; $v_3 = 215$.

It will be found on further trial that the values given by this second approximation are all very nearly correct, the only exception being i_3, whose new value is 2.43. By adopting, therefore, the method just explained, we need not go beyond the second approximation. Having explained in detail how the calculation proceeds, we subjoin the following table of values of I, *i*, V, and *v* :

No. of time-interval.	Time.	I.	*i*.	V.	*v*.
1	.5 × 10−4	16.46	.134	816	6.7
2	1 ,, ,,	32.22	.794	3,204	53
3	1.5 ,, ,	46.81	2.434	6,994	214
4	2 ,, ,,	59.80	5.39	11,930	,605
5	2.5 ,, ,,	70.88	9.93	17,700	1,371
6	3 ,, ,,	79.86	16.23	23,926	2,679
7	3.5 ,, ,,	86.67	23.84	30,250	4,682
8	4 ,, ,,	91.35	32.63	36,325	7,505
9	4.5 ,, ,,	94.07	42.17	41,830	11,245
10	5 ,, ,,	95.05	51.91	46,582	15,949
11	5.5 ,, ,,	94.60	61.25	50,400	21,607
12	6 ,, ,,	93.05	69.58	53,245	28,150
13	6.5 ,, ,,	90.72	76.32	55,138	35,444
14	7 ,, ,,	87.96	80.97	56,207	43,308
15	7.5 ,, ,,	84.96	83.15	56,646	51,514
16	8 ,, ,,	81.90	82.66	56,700	59,804
17	8.5 , ,,	78.86	79.46	56,682	67,910
18	9 ,, ,,	75.84	73.69	56,759	75,567
19	9.5 ,, ,,	72.76	65.63	57,223	82,533
20	10 ,, ,,	69.46	55.74	58,265	88,610
21	10.5 ,, ,,	65.73	41.58	60,008	93,626
22	11 ,, ,,	61.34	32.74	62,495	97,492
23	11.5 ,, ,,	56.05	20.88	65,683	100,173
24	12 ,, ,,	49.56	9.6	69,439	101,697
25	12.5 ,, ,,	41.93	− 1.46	73,606	102,104
26	13 ,, ,,	32.95	− 10.31	77,940	101,516
27	13.5 ,, ,	22.66	− 17.12	82,092	100,145
28	14 ,, ,,	11.17	− 22.01	85,740	98,189
29	14.5 . ,,	− 1.28	− 25.06	88,588	95,836
30	15 ,, ,,	− 14.39	− 26.19	90,382	93,258
31	15.5 ,, ,,	− 27.74	− 26.65	89,812	90,600
32	16 ,, ,,	− 40.56	− 26.32	89,068	87,950
33	16.5 ,, ,,	− 52.77	− 25.6	86,908	85,404
34	17 ,, ,,	− 63.96	− 24.95	83,690	82,876
35	17.5 ,, ,,	− 73.78	− 24.74	79,288	80,392
36	18 ,, ,,	− 81.89	− 25.32	74,008	77,889
37	18.5 ,, ,,	− 88.06	− 26.9	68,121	75,278
38	19 ,, ,,	− 92.16	− 29.57	61,933	72,455
39	19.5 ,, ,,	− 94.18	33.26	55,758	69,314
40	20 ,, ,,	− 94.19	− 37.81	49,893	65,811
41	20.5 ,, ,,	92.34	− 42.92	44,603	61,775
42	21 ,, ,,	− 88.88	48.18	40,097	57,225
43	21.5 ,, ,,	− 84.00	− 53.44	36,513	52,160
44	22 ,, ,,	− 78.25	− 57.61	33,952	46,609
45	22.5 ,, ,,	− 71.88	− 60.51	32,352	40,703
46	23 ,, ,,	− 65.18	− 61.78	31,614	34,589
47	23.5 ,, ,,	− 58.42	− 61.13	31,580	28,444
48	24 ,, ,,	− 51.80	58.48	32,050	22,943
49	24.5 ,, ,,	− 45.44	− 53.89	32,805	17,325
50	25 ,, ,,	− 39.42	− 47.23	33,618	12,269
51	25.5 ,, ,,	− 33.70	− 38.86	34,266	7,965
52	26 ,, ,,	− 28.19	− 29.12	34,572	4,564
53	26.5 ,, ,,	− 22.76	− 18.50	34,406	2,183
54	27 ,, ,,	− 17.24	− 7.51	33,707	883
55	27.5 ,, ,,	− 11.46	+ 3.30	32,483	673
56	28 ,, ,,	− 5.26	+ 13.42	30,811	1,509
57	28.5 ,, ,,	+ 1.5	+ 22.38	28,833	3,299

A glance at the values contained in the above table, from which the curves shown in Figs. 13 to 19 have been plotted, immediately reveals several highly interesting facts. As soon as the P.D. of 50,000 volts is applied to the line, a charging current begins to flow into it which, in the first



section of our model, increases up to the end of the tenth interval. During this time, the source of E.M.F. is supplying energy to the line in three distinct ways: (1) in raising the temperature of the conductors by the heating effect due to the current; (2) in building up the magnetic field surrounding the conductors; (3) in building up the electric (or electrostatic) field around the conductors. (1) corresponds to *dissipation*, and (2) and (3) to *storage* of energy. By the end of the tenth interval the magnetic field around the conductors forming the first section has reached its maximum value, and beyond this point it begins to decrease. As the magnetic field collapses, it gives rise to an induced E.M.F. in the first section of the line which is added to the impressed P.D. of 50,000 volts, so that the available E.M.F. considerably exceeds this limit, and the first condenser becomes charged, as seen from the table, to a P.D. largely in excess of 50,000 volts. While this is taking place—*i.e.*, from the eleventh to the end of the thirtieth interval—we have (in the first section of our line) the transformation of electromagnetic into electrostatic energy, the energy of the collapsing magnetic field taking the form of the increasing electrostatic energy of the first condenser. Similar changes, it will be noticed, are taking place in the second section, and just before the end of the twenty-fifth interval the current in the second section has reached a zero value, *while the P.D. at the end of the line is practically double the impressed P.D.** At this instant, the second section contains no magnetic, but only electrostatic, energy. Beyond the twenty-fifth interval the electrostatic energy begins to undergo a transformation into magnetic energy, a current appearing in the second section (*see* dotted curve in Fig. 13), which flows against the direction of the impressed P.D. A little later, a similar change begins to take place in the first section, the current in which, after

* It would always be rather *less* than double the impressed P.D. The fact that in our table we obtain a value (102,104) which is *more* than double the impressed P.D. is due to a want of accuracy in our method, which, it must be remembered, is only *approximate*.

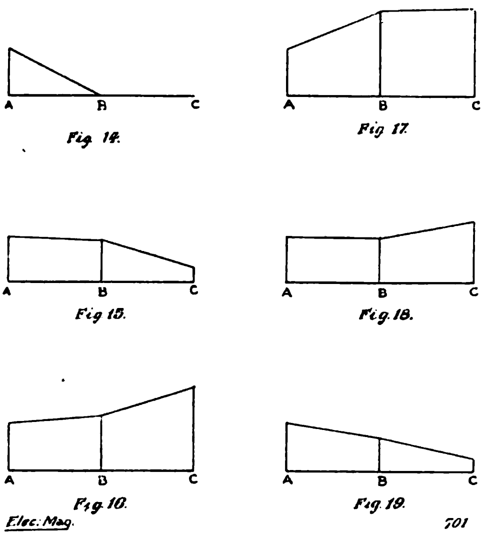


Fig. 14. Fig. 17. Fig. 15. Fig. 18. Fig. 16. Fig. 19.

passing through a zero value during the twenty-eighth interval, flows *against* the direction of the impressed P.D. This *discharging* current in the second section passes through a zero value during the fifty-fifth interval, and in the first section during the fifty-seventh interval. A new rush of charging current then begins ; it is, however, evident (without continuing the somewhat laborious calculation beyond the fifty-seventh interval) that the second wave of charging current will reach a much smaller maximum than that reached by the first wave ; for at the commencement of the first wave, there was no P.D. across either condenser to oppose the current, whereas at the commencement of the second wave (fifty-seventh interval) we have an opposing P.D. of over 28.000 volts across the first condenser. As a further consequence, the current wave in the second section will also reach a much smaller maximum, and hence the P.D. across the end of the line will, at the instant when the current reaches a zero value, be much less than 100,000 volts. This gradual reduction of amplitude or *damping* will go on until the current waves become imperceptible, and with them also the fluctuations in the P.D., the current ultimately disappearing and every portion of the line assuming a final steady P.D. of 50,000 volts.

This charging of the line, however has taken place by a *series of oscillations*, consisting in a periodic transformation of energy from the electrostatic to the electromagnetic form, and *vice versâ*, and the different points of the line have during the oscillations been raised to P.D.s approaching *double* the impressed P.D. It is sufficiently obvious from this that a transmission line may, at the instant of switching on, be called upon to stand voltages greatly in excess of the normal voltage.

A hydraulic analogy will again help the reader to form a correct mental picture of the actions involved. Consider a very long tube with elastic walls, closed at one end, and completely filled with an incompressible liquid. The capacity of our transmission line is represented by the elasticity of the walls of the tube, and its self-inductance by the mass or inertia of the liquid filling the tube. *Potential* corresponds to liquid *pressure*, *current* to liquid *flow*. Imagine a piston to be suddenly forced into the tube, so as to send a pressure wave along it. The liquid is set in motion, distending the walls of the tube. The potential energy of the distended walls is the analogue of electrostatic energy, while the kinetic energy of the moving liquid is the analogue of electromagnetic energy. When the pressure is first suddenly applied to the end of the tube, and before the motion has had time to travel along it, the nearest portions of the liquid distend the walls beyond their equilibrium position. The walls then again collapse, driving the liquid into the further portions of the tube, where the walls again become distended beyond the equilibrium position, again collapse and drive the liquid further, and so on, until the closed end of the tube is reached. Here a *reflection* of the wave takes place, the distended closed end of the tube (representing the charged condenser at the end of the second section of our transmission line model) in collapsing starts a flow of the liquid in the opposite direction, the wave now running backwards along the tube. After a certain number of oscillations, the waves become imperceptible, and the elastic tube is uniformly distended.

The oscillations in the potential along our transmission line model are represented in Figs. 14 to 19. In these figures A represents the end of the line which is maintained at the fixed P.D. of 50,000 volts, B is the middle point—*i.e.*, the point of attachment of our first condenser in the model—and C the insulated end of the line, corresponding to the point of attachment of the second condenser in the model (*see* Fig. 12). Horizontal distances represent distances along the line, vertical distances values of the P.D. The broken line, consisting of two straight-line portions, is the curve of P.D. along the line. The positions of the line shown correspond to the instant of closing the circuit (Fig. 14), and to consecutive equal intervals of 5×10^{-3} sec. The positions of the three points defining the broken line are obtained from the table given above. One end of the line is anchored, since it is maintained at a constant P.D. The middle and far end sway about. The amplitude of these vibrations

gradually decreases, and ultimately the two portions of the broken line become fixed into a single continuous straight line parallel to the horizontal axis and at a distance above it representing 50,000 volts.

In the case of an actual transmission line, the distribution of potential would, of course, be represented, not by a broken line, but by a continuous curve. The wave of potential on reaching the end of the line would undergo reflection, and before reflection occurred the P.D. would rise to about double the impressed P.D. A point to which special attention may be drawn is the very high frequency of the oscillations we have been considering. A complete wave, as is evident by reference to the table or the curves of Fig. 13, occupies fifty-six of our time-intervals, or 28×10^{-4} sec. Hence the frequency of the oscillations is $\frac{10,000}{28}$ or 357 complete waves per second. This is much higher than the usual commercial frequencies for alternating currents. If, therefore, the impressed P.D. is an alternating one, and we suppose the transmission line to be switched on at a certain instant, then, so far as the natural high frequency oscillations of the transmission line are concerned, the impressed P.D. may be regarded as practically constant during the first natural oscillation wave. Assuming the switch to be closed at the instant of maximum value of the alternating impressed P.D., we see that the transmission line will be subjected to a voltage equal to nearly double the maximum voltage of the alternating P.D. wave.

Problems in Dynamo Design.—VI.

ARMATURE CALCULATIONS.

By ELLIS H. CRAPPER, M.I.E.E.

The formulæ. $E = \frac{NCn}{10^8 \times 60}$ (1a) and $E = 4\,\phi\,Cn_1 \times 10^{-8}$ (1c), which express the magnitude of the electromotive force generated in a continuous-current armature require modification when applied to the predetermination of the effective E.M.F. per phase given by an alternator, and one or more numerical coefficients have to be introduced into the above formulæ. In general terms we may write

$$E_a = K.E_c$$

where E_a and E_c denote respectively the effective E.M.F.s generated on open circuit by alternators and continuous-current dynamos of identical construction, and K is a numerical coefficient the value of which depends upon (1) the wave form of the E.M.F. and (2) the relative distribution of the armature winding and magnetic flux; and if k_f and k_w are the numerical constants which deal with these elements we have

$$K = k_f \times k_w.$$

The coefficient k_f is known as the *form-factor*, and its value is given by the ratio of the effective or virtual value to the average value (*i.e.*, arithmetical mean) of the E.M.F.; it is a useful and necessary coefficient when the wave form of the alternating quantity produced has to be taken into account. Restricting ourselves to the sine wave of electromotive forces, the value of k_f is readily ascertained, since

$$\left.\begin{array}{l}\text{average value}\\ \text{of a sinusoidal}\\ \text{quantity}\end{array}\right\} = \frac{2}{\pi}\left\{\begin{array}{l}\text{times the maxi-}\\ \text{mum value}\end{array}\right.$$

$$\text{or } E_{av} = \frac{2}{\pi} E_{max} = 0.636\, E_{max}$$

and

$$\left.\begin{array}{l}\text{the virtual value}\\ \text{of a sinusoidal}\\ \text{quantity}\end{array}\right\} = \frac{1}{\sqrt{2}}\left\{\begin{array}{l}\text{times the maxi-}\\ \text{mum value}\end{array}\right.$$

$$\text{or } E_v = \frac{1}{\sqrt{2}} E_{max} = 0.707\, E_{max}$$

$$\therefore \quad k_f = \frac{E_v}{E_{av}} = \frac{0.707\, E_{max}}{0.636\, E_{max}} = 1.11$$

With peaky waves k_f is greater than 1.11, and for flat-topped waves it is less than 1.11, becoming unity for rectangular waves. The effective value of the E.M.F. also depends upon the arrangement of the armature winding (which may be concentrated or distributed), breadth of coil, pole-width, pitch, &c., and the second factor, k_w, taking into account these relations, is known as the *breadth, width,* or *distribution coefficient,* the value of which is given by the ratio of the average value (arithmetical mean) to the gross average value of the E.M.F. induced when differential action is supposed to be absent, and all the lines of force of the flux are assumed to be cut usefully. A little consideration shows that the values of both k_f and k_w depend upon:

(1) the ratio of the pole-width to the pitch;

(2) the ratio of the width of the winding to the pitch.

In the case of slotted armatures the values of these factors depend upon the relative position of the slots when one side of a drum coil is distributed among more than one slot. In what follows, the method adopted in general practice will be followed and the assumption made that the flux from one pole is strictly confined to the width of the pole-face and is uniform over its whole area in which case the half-wave of E.M.F. given by a single inductor or group of inductors in one slot per pole would enclose with the abscissa axis a rectangle so that the distribution coefficient k_w will be unity.

The general expression for the E.M.F. per phase of an alternator may be given as

$$E = 4\, k_f k_w\, \phi\, C n_1 \times 10^{-8} \text{ volts} \quad . \; . \; . \; (1d)$$

and assuming k_w is unity we have

$$\left.\begin{aligned} E &= 4\, k_f \phi C n_1 \times 10^{-8} \text{ volts} \\ &= 4.44\, \phi C n_1 \times 10^{-8} \text{ volts} \end{aligned}\right\} \; . \; . \; . \; (1e)$$

since $k_f = 1.11$ for sinusoidal quantities.

In this formula, n_1 is the actual periodicity or number of magnetic cycles per second, *i.e.*, n_1 = revolutions per second × number of pairs of poles or $n_1 = n \times p$, therefore we may write

$$E = 4.44\, \phi C n p \times 10^{-8} \text{ volts} \quad . \; . \; . \; (1f)$$

If the formula (1a) be preferred, then

$$E = 2.22\, N C n p \times 10^{-8} \text{ volts} \quad . \; . \; . \; (1g)$$

in which C denotes the number of inductors per phase and not convolutions.

EXAMPLE 1.—*The armature of an alternator consists of* 400 *conductors* (i.e., 200 *turns*), *connected in series, and the periodicity of the resulting E.M.F. is* 50 *cycles per second. The magnetic flux per pole is* 2.5 *megalines. Determine the E.M.F. generated at no load, and also the number of revolutions per minute, given that there are* 20 *conductors per slot per pole.*

By substitution,

$$E = \frac{4.44 \times 2.5 \times 10^6 \times 200 \times 50}{10^8}$$

$$= 1110 \text{ volts.}$$

Since there are twenty conductors per slot per pole, it is clear that there are twenty poles, and since

$$\text{periodicity} = \frac{n}{60} p$$

$$50 = \frac{n}{60} \times 10$$

$$\therefore\; n = 300 \text{ revolutions per minute.}$$

In the case of polyphase generators, the same formulæ apply, provided that attention be paid to the method of inter-connecting the windings of the different phases. Thus, with two-phase machines the two sets of windings 90 degrees apart may be brought to four slip-rings or to three slip-rings so as to feed a four-wire or three-wire two-phase system, as shown in Fig. 1 (I, II). These figures refer to bipolar machines for the sake of simplicity, and it should be noted that the result is the same whether the two sets of windings are perfectly independent, as shown (Fig. 1), or whether they be connected together at their middle points, provided each set be brought to the proper pair of rings. The above formulæ apply as in single-phase alternators, provided that C denotes the number of convolutions or conductors, as the case may be, per phase.

If, however, two corresponding ends of the windings be connected together, as shown in Fig. 1 (II), and three rings be used, the line voltage is not the same as the effective E.M.F. induced in each phase-winding, but is the resultant of the two E.M.F.s in quadrature with each other (*i.e.*, 90 degrees apart), therefore

$$E_1 = \sqrt{2}\, E$$

where E_1 is the terminal voltage and E is the E.M.F. generated in each phase, and by substitution we have

$$\left.\begin{aligned} E_1 &= \sqrt{2} \times 4.44\, \phi C n_1 \times 10^{-8} \text{ volts} \\ &= 6.28\, \phi\, C n_1 \times 10^{-8} \text{ volts} \end{aligned}\right\} \; . \; (1e')$$

or

$$\left.\begin{aligned} E_1 &= \sqrt{2} \times 4.44\, \phi C n p \times 10^{-8} \text{ volts} \\ &= 6.28\, \phi\, C n p \times 10^{-8} \text{ volts} \end{aligned}\right\} \; . \; (1f')$$

or

$$\left.\begin{aligned} E_1 &= \sqrt{2} \times 2.22\, N C n p \times 10^{-8} \text{ volts} \\ &= 3.14\, N C n p \times 10^{-8} \text{ volts} \end{aligned}\right\} \; . \; (1g')$$

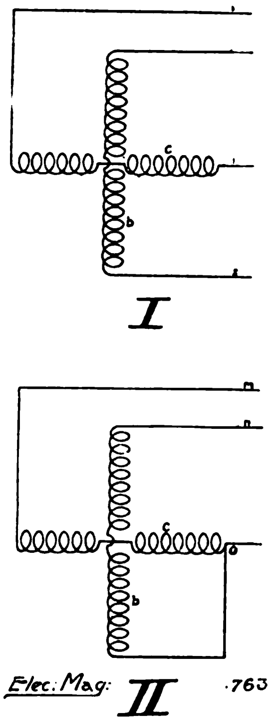


FIG. 1.

EXAMPLE 2.—*Determine the number of armature conductors required per phase for a two-phase three-wire generator giving a terminal voltage of* 2,110 *volts, given that there are* 40 *poles, the area of each pole-face being* 700 *square centimetres, and that the flux density is* 8,000 *C.G.S. lines. The armature is slotted and there is one slot per pole per phase. How many conductors are there in each slot? The speed is* 150 *revolutions per minute.*

Using formula (1e′), the periodicity n_1 is

$$n_1 = \frac{150}{60} \times 20 = 50 \text{ cycles per second}\cdot$$

$$\phi = 8000 \times 700 = 5600000.$$

If C_1 = number of conductors required, then C, the number of convolutions or turns,

$= \frac{C_1}{2}$, and by substitution

$$2110 = 6.28 \times 5600000 \times \frac{C_1}{2} \times 50 \times 10 -$$

$$\therefore\; C_1 = 240 \text{ conductors}$$

and number of conductors per slot $= \frac{240}{40} = 6.$

The armature conductors of three-phase generators may be connected as a *mesh-winding* (Fig. 2 (I)), or as a *star-winding* (Fig. 2 (II)), and the character-feature of three-phase armatures is that there are three sets of armature coils displaced 120 degrees (electrical) apart.

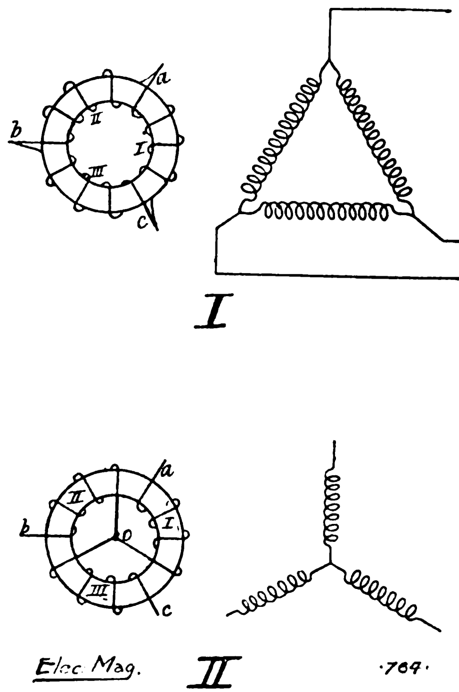


FIG. 2.

In both types of windings there are three slip-rings and three wires for the external circuit, but the relation existing between the interlinked (or line) pressure and the pressure induced per phase is different in the two types of interconnection. Thus, the interlinked pressure is the *same* as the pressure generated per phase in the case of the *mesh* arrangement, and formulæ (1e), (1f) and (1g) apply as in single-phase machines if C denotes the number of turns or conductors (as the case may be) per phase. In the case of the *star* arrangement, the three corresponding ends of the three sets of coils are connected so as to form a common junction (Fig. 2 (II)), the remaining ends being connected to the three slip-rings to form the terminals of the machine, and a little consideration will suffice to show that the interlinked pressure, or the E.M.F. between two rings, is the resultant or vector sum of two E.M.F.s with a phase relation of 120 degrees. Therefore

$$E_3 = \sqrt{3}E_1 = 1.732\ E_1$$

where E_3 and E_1 denote respectively the terminal pressure and induced (phase) pressure. As regards the current, it is perfectly obvious that the line current and armature current are the same with the star-winding, but that in the mesh-winding the line current is the resultant of two equal currents (for a balanced system), with a phase relation of 120 degrees, consequently the line current is $\sqrt{3}$ or 1.732 times the current in each leg of the armature winding.

EXAMPLE 3.—*How many poles would be required if the rotor of a three-phase generator turned at 120 revolutions per minute, and the frequency of each current was to be 60. Calculate the product C × ϕ if the voltage is to be 10,000 where C stands for the number of turns in each of the three rotor-windings, and ϕ is the mean effective flux in C.G.S. lines emanating from one field-pole.* (City and Guilds, Electric Light and Power Transmission, 1901.)

Since frequency $= \frac{n}{60} \times p$

we have

$$\text{number of poles} = 2p = \frac{60 \times 60}{120} \times 2$$
$$= 60 \text{ poles.}$$

As the type of winding is not mentioned in the question, we may assume the mesh connection, and applying formula (1e) we have

$$E = 4.44\ \phi C n_1 \times 10^{-8} \text{ volts}$$
$$\therefore \quad 10000 = 4.44\ \phi C \times 60 \times 10^{-8}$$
$$\text{and} \qquad C\phi = \frac{10^{12}}{266.4}$$
$$= 375 \times 10^{7}$$

EXAMPLE 4.—*What is the E.M.F. induced per phase in a star-connected 40-pole three-phaser running so that the frequency is 30 cycles per second, if the magnetic flux is 5 megalines per pole? The armature is slotted and there is one slot per pole and phase, and each slot contains 24 conductors, all the coils per phase being connected in series. Also determine the line voltage.*

To determine the effective E.M.F. per phase, apply formula (1e), and we have

$$E = 4.44\ \phi C n_1 \times 10^{-8} \text{ volts}$$
$$= 4.44 \times 5000000 \times \frac{24 \times 40}{2} \times 30 \times 10^{-8}$$

since there are 40 slots per phase, and two conductors are required to make a convolution or turn, therefore

$$E = 3197 \text{ volts.}$$

The interlinked or line pressure is $\sqrt{3}$ times the effective armature pressure, therefore

$$E_3 = \sqrt{3} \times 3197$$
$$= 1.732 \times 3197$$
$$= 5537 \text{ volts}$$

Drop in Volts in the Armatures of Alternators.—The voltage drop in the armatures of alternators increases much more rapidly with increases of load than in direct-current armatures of the same capacity. In the latter case the volts lost in the armature are proportionate to the armature current and are made up of CR losses and armature reactions, whilst the drop in pressure in the armatures of alternators under load is due to the combination of two causes, armature impedance and armature reaction. The impedance drop is the loss in pressure which

occurs in the armature coils owing to the *reactance* as well as the resistance of the armature windings, consequently impedance drop is made up of two components in quadrature with one another, *i.e.*, reactance drop and resistance drop. The reactance drop is due to the self-induction set up by the interlinkage of the local flux around the armature conductors as the result of the current traversing them, consequently this flux depends directly upon the current in each conductor, but is inversely proportional to the reluctance of the magnetic path surrounding the conductors. When a number of conductors occupy the same slot the flux due to the separate currents in the several conductors surrounds the other conductors, and it follows that the relative number of linkages will be proportional to the square of the number of conductors in each slot. The reactance drop, moreover, is not only a function of the armature current, in so far as this tends to saturate the armature core magnetically, but it is also a function of the field excitation and of the shape of the polar surface, since the reactance varies cyclically with the rotation of the moving parts. Numerically, the impedance of the armature of an alternator is practically all reactance, since the resistance is comparatively small. The question of armature drop is important, on account of its influence upon the *regulation* of an alternator, and the problem is rendered quite complex because of armature reaction, the component drop in consequence being due principally to the demagnetising effect of the magnetomotive force of the armature current upon the magnetic circuit supplied by the field windings. To simplify matters, the question of armature reactions will not be introduced in these notes. As is well known, the *regulation* of an alternating current generator is defined as *the ratio of the rise in voltage from full load to no load at constant speed and excitation to the full load voltage.*

The pressure drop in the armatures of alternators under load may be treated graphically, and, leaving out armature reactions, there are two cases to be considered: (1) non-inductive loads, and (2) inductive loads. In the case of non-inductive loads let OC in Fig. 3 (II) represent the current supplied by the alternator, and OE_t the terminal P.D. which is in phase with the current. If L be the inductance of the armature, the reactance $= \omega L = 2\pi f L$, and the reactive E.M.F. $= \omega LC = E_s$.

Also let OE_s, perpendicular to OC, represent E_s, and OR_1 in phase with OC represent $E_r = C \times R$ the resistance drop of the armature. R being the resistance of the armature and C the current, then OE_a denotes the resultant of E_s and E_r.

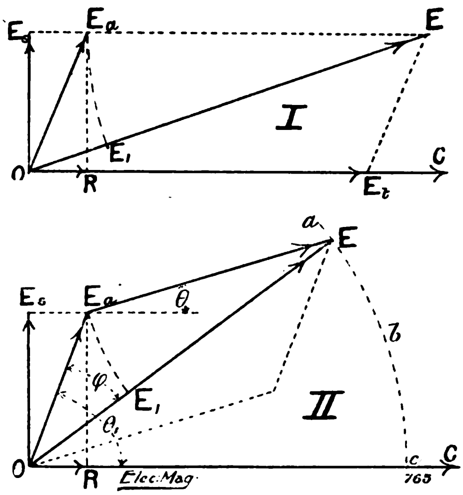


Fig. 3.

The resultant or vectorial sum of OE_t and OE_a or OE will obviously denote the E.M.F. generated in the armature. The pressure drop in the armature is numerically given by the difference between OE and OE_t, and is represented by the vector E_tE_1 in the figure.

In the case of an inductive load, let us assume that OE (Fig. 3 (II)) is the E.M.F. induced on open circuit at the given speed excitation, and is known, and also that the power-factor of the external circuit is Cos θ, θ being the phase difference between the current and terminal pressure. Using the same symbol as before, we have

reactive E.M.F. $E_s = \omega LC$

resistance drop $E_r = C \times R$

and in Fig. 3 (II) let OC represent the current. From O as centre with radius equal to the open circuit E.M.F., describe the arc *abc*, and let OE_s represent the reactive E.M.F. E_s and OR the resistance drop E_r, then OE_a will represent the resultant of OE_s and OR. From the extremity E_a of OE_a introduce the line OE, making an angle θ (given by the power-factor Cos θ) with the direction E_aR_1, parallel to OC, and long enough to cut the arc *abc* at E. By joining O and E we have the vector diagram OE_aE, the sides of which represent the following pressures in magnitude and direction, OE (pressure generated), E_aE (terminal pressure), and OE_a (the resultant of E_s and E_r). The drop in the armature is given by taking the numerical difference between OE and EE_a, *i.e.*, by OE_1, the value of which is clearly $OE_a \cos \psi$. The numerical value of the impedance drop is therefore given by

$$\text{impedance drop} = OE_a \cos \psi$$
$$= C\sqrt{R^2 + \omega^2L^2} \cos \psi$$
$$= C\sqrt{R^2 + \omega^2L^2} \cos (\theta_1 - \theta)$$

where θ_1 is the phase relation between E_a and C, since OE and E_aE are approximately parallel to each other, and $\psi = \theta_1 - \theta$ approximately.

EXAMPLE 5.—*The armature resistance of a certain alternator is 2 ohms, the inductance being 0.05 henry. The excitation is such that an E.M.F. of 2,000 volts is obtained on open circuit. The frequency is 35 cycles per second. Find the P.D. across the alternator terminals when loaded with a current of 25 amperes on an inductive circuit the power-factor of which is θ.8.*

The student is recommended to construct the vector diagram as explained above, making use of the following numerical data:

Since $\text{Cos } \theta = 0.8$

$\theta = 37°$ (from table of Cosines)

$$\text{Reactive E.M.F.} = \omega LC = 2\pi f LC$$
$$= 2 \times \frac{22}{7} \times 35 \times 0.05 \times 25$$
$$= 275 \text{ volts}$$

$$\text{Resistance drop} = C \times R = 25 \times 2 = 50 \text{ volts}$$

$$\text{The impedance drop} = C\sqrt{R^2 + \omega^2L^2}\,\text{Cos}\,(\theta_1 - \theta)$$

$$\text{Now } \tan\theta_1 = \frac{E_x}{E_r} = \frac{\omega LC}{CR}$$
$$= \frac{\omega L}{R} = \frac{\frac{2 \times 22}{7} \times 35 \times 0.05}{2}$$
$$= 5.5$$

$\therefore \quad \theta_1 = 80°$ (from table of tangents)

$\therefore$ impedance drop

$$= 25\sqrt{2^2 + \left(2 \times \frac{22}{7} \times 53 \times 0.05\right)^2}\,\text{Cos}\,(80° - 37°)$$
$$= 25 \times 11.18 \times \text{Cos } 43°$$
$$= 25 \times 11.18 \times 0.7313$$
$$= 204.4 \text{ volts}$$

$\therefore$ terminal P.D. $= 2000 - 204.4 = 1795$ volts

(*To be continued.*)

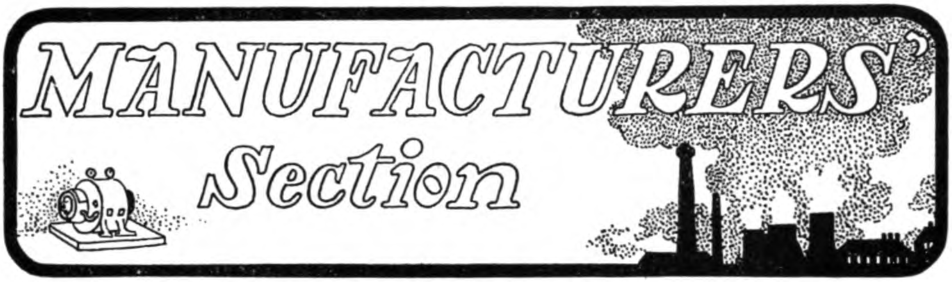
From Professor to Student.

I WISH to deposit iron, and also steel, on a carbon plate, and would like to know what chemicals I need to carry it out.

To secure a satisfactory deposit of iron is one of the most difficult operations in electrolysis. Electrolytic iron is characterised by its extreme hardness and brittleness, but on being annealed becomes very soft and tough. If an attempt is made to obtain a *thick* deposit, very serious difficulties are encountered. The consecutive layers tend to split off from each other, and unless the current-density is very uniform over the entire cathode area the deposit tends to assume a curved form and to become separated from the cathode. It may be said that at the present time no thoroughly satisfactory process of producing thick deposits of electrolytic iron is known, in spite of the large number of efforts which have been directed towards the solution of this problem. Among the large number of solutions from which iron may be deposited electrolytically, the most satisfactory are the ferrous sulphate ($FeSO_4$) and ferrous chloride ($FeCl_2$) solutions. The first, which is known as Klein's solution, is prepared by dissolving equal weights of ferrous sulphate and magnesium sulphate in water until the specific gravity of the solution reaches 1.05. It is *absolutely essential* to prevent this both from becoming acid, and this may be done by suspending in it muslin bags containing magnesium carbonate. The anodes should be of pure iron, and their area about eight times as great as that of the cathode; the current-density should not exceed about .015 ampere per square inch of cathode area, and the temperature of the solution should be kept as high as possible. The following method of producing fairly thick deposits, which involves the use of a ferrous chloride solution is protected by a German patent (No. 126,839, Dec. 2, 1900) granted to E. Merck. Ferrous chloride is dissolved in its own weight of water. The bath is maintained at about 70° C., and continuous circulation of the electrolyte is maintained by revolving the cathode or other suitable means. The invention, it may be explained, does not consist in the use of a ferrous chloride solution (this solution having been used for electro-deposition as far back as 1861), but in the use of this solution under the particular conditions specified.

S. J. HARBOTTLE.—Will you kindly give me your advice as to what books I should buy in order to gain, by study, assistance in my work. I am an apprentice in a Corporation Electric Light and Power Station, having gone there straight from school. I should also be much obliged for some general advice.

IN offering the following advice as to your training it is presumed that you have received no technical or college training, and also that you are determined to succeed in your profession. Obviously a great deal will depend upon your own efforts, and if it be possible we advise you to attend the evening-classes at the local technical or science school. Presuming that you have opportunities for receiving the practical side of your training the branches of study recommended are (1) Theoretical and Applied Electricity; (2) Mathematics, and (3) Steam and Machine Drawing. For the first year it will probably be best to omit No. 3, and devote all your time to Nos. 1 and 2. We cannot urge you too strongly to obtain a good knowledge of elementary mathematics. To begin with algebra, Hall and Knight's Elementary Algebra — with answers — is a good book. With respect to the study of Electrical Engineering you should first get a good grounding in the elementary principles and the following books are recommended. For continuous currents: Tyson's Sewell's *Elements of Electrical Engineering* (Crosby Lockwood and Sons), and Crapper's *Electric and Magnetic Circuits* (E. Arnold); the latter book is particularly useful for electric calculations. For Alternating Currents you cannot do better than begin with Hay's *Alternating Current Working* (Biggs and Co.) but you will scarcely be ready for this during the first year. If you attend a technical school you will probably be advised to take—as soon as you are ready—the examinations of the City and Guild Institute in Electric Lighting and Power Transmission, and we are certainly of an opinion that the value of the certificates awarded by the Institute to successful students cannot be overestimated. We wish you success in your efforts.



A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section at end of Magazine.

Worthington Centrifugal Pumps.

It is just 200 years since Denis Papin invented his famous pump on the centrifugal principle. This form of pump has remained almost stationary in design until recent years, when considerable attention has been given to its possibilities. A fifty-feet head was considered high some years ago, but 2,000 feet is now practicable.

The Worthington Pump Company, Ltd., 153, Queen Victoria Street, London, E.C., has recently devoted a great deal of attention to the design and construction of centrifugal pumps. They are now able to produce these pumps for heads up to 2,000 feet, and of very high efficiencies. Their centrifugal pumps are divided into three classes—Conoidal, Volute and Turbine. The conoidal centrifugals are designed especially for low lifts and large deliveries, and are adapted to irrigation and similar work. They operate at high rotative speeds, making possible direct connection to electric motors. For heads up to thirty feet they are very efficient. The volute centrifugals are built for medium lifts, but for all capacities. Since they run at moderate speeds, diffusion vanes are not needed, but the volute casing has been so designed as to obtain high efficiencies, 86 per cent. being shown under test. These pumps are, we understand, recommended for heads up to 70 feet, although they will safely withstand 150 feet. The turbine pump is suited to very high lifts, even exceeding 2,000 feet.

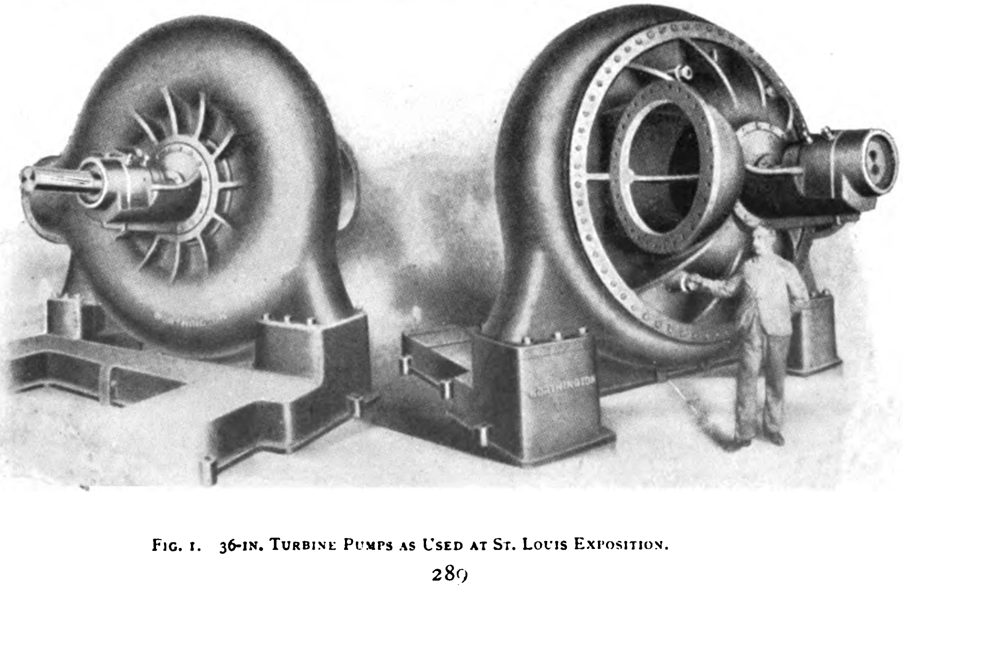


Fig. 1. 36-in. Turbine Pumps as Used at St. Louis Exposition.

Fig. 1 shows a 36-inch turbine pump, with a capacity of 29,000 gallons per minute against 160 feet head of water. Three of these pumps, each driven by a 2,000 h.p. electric motor, are in use now supplying the grand cascade at the World's Fair, St. Louis Exposition, 1904. Multi-stage turbine pumps are also made by the Company, and are especially adapted for deep mine work, where heavy pressures are encountered. They can be adapted to any capacity, and for heads up to 2,000 feet. Fig. 2 shows a 12-in. two-stage vertical turbine pump, designed for direct connection to a vertical-shaft electric motor. This pump has a capacity of 4,150,000 gallons per day against 140 feet head, and is used for general water service at a large steel works.

The Worthington turbine pump, as shown in these illustrations, has been developed by a long series of elaborate experiments carried out under the direction of the Company's engineers. In these pumps, the diffusion vanes, which form the distinguishing feature, take the place of the usual whirlpool chamber in other forms of centrifugal pumps and assist in bringing the water to rest without internal commotion or shock. They correspond in function to the guide vanes of turbine water-wheels. One of the difficulties presented by high-lift centrifugal pumps has been the great peripheral speed required when only a single impeller is employed. This has been overcome in the Worthington multi-stage turbine pump by mounting a number of discs or impellers, each operating in a separate chamber, upon a single shaft and passing the water through the impeller chambers in succession. The lift can thus be multiplied three, four or five times, while the number of revolutions is kept within such bounds that it is possible to connect the pump directly to a steam-engine or an electric motor. It has been demonstrated by experiment that on the same work and within reasonable limits multi-stage centrifugals are more efficient than single-stage pumps, the increased efficiency being due to a decrease in the frictional losses coincident with the reduced peripheral speed of the impeller. Great attention has been devoted to the mechanical details in order to produce a machine that would withstand the most severe service for long periods of time without renewals or repairs. The bearings are supplied with ring oilers and are lined with the best quality of Babbitt's metal hammered in, reamed true, and scraped to a perfect fit. In all except the very small sizes, these bearings have been entirely

FIG. 2. 12-IN. TWO-STAGE VERTICAL CENTRIFUGAL PUMP.

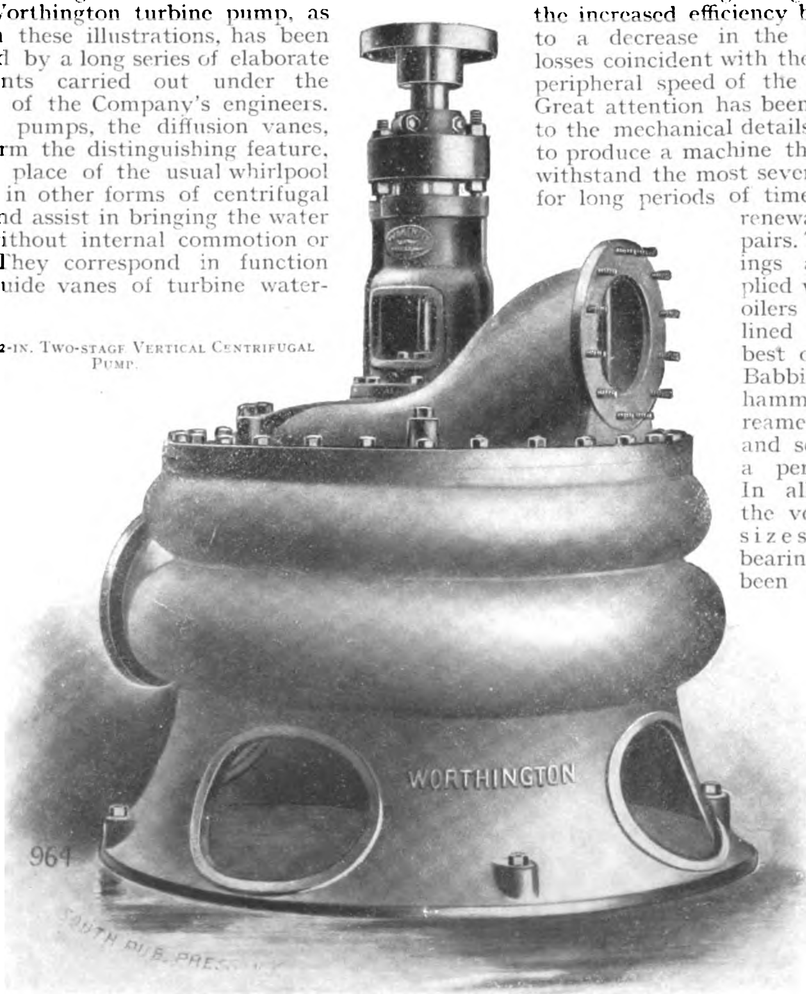
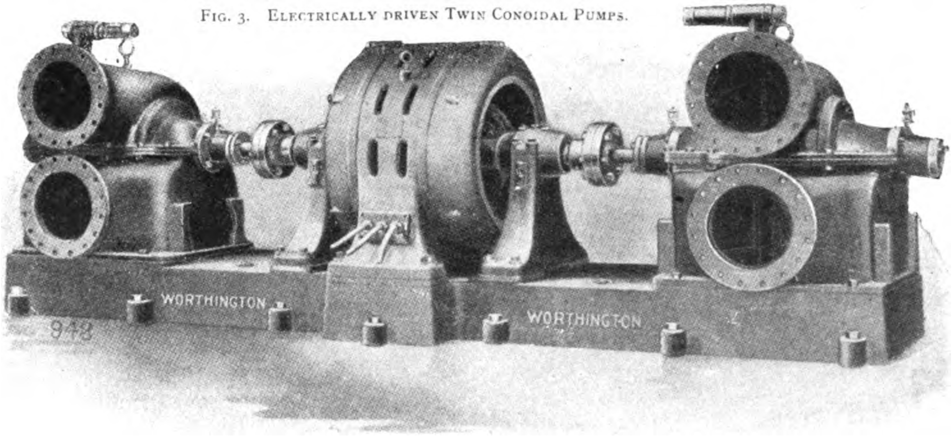


FIG. 3. ELECTRICALLY DRIVEN TWIN CONOIDAL PUMPS.



separated from the pump casing, an improved form of construction, effectually eliminating all possibility of foreign matter working into the bearings when the pump is handling water containing silt or sand. This construction further makes it possible to renew the bearings without entirely dismantling the pump. All parts are made to gauge, and special tools are used to produce every part with mathematical accuracy. Special attention has been paid to the impeller. In the Worthington turbine pump only suction and discharge pipes are employed, the water entering axially and issuing radially. The impellers remain in perfect longitudinal balance regardless of their number or the head against which the pump is operated; this balancing of the impeller is secured by a highly ingenious patented system of "triple vanes." To produce an efficient high-lift centrifugal pump it is necessary to convert the kinetic energy of the water in motion into potential energy of water under static head. In this turbine pump the efficient conversion of energy is obtained by a patent system of diffusion vanes disposed in the throat opening between the periphery of the impeller and the annular casing, in a similar manner that guide vanes are placed in a reaction turbine water-wheel. These vanes form tangential expanding ducts from which the fluid emerges at about the velocity existing in the chamber. They also eliminate all drag

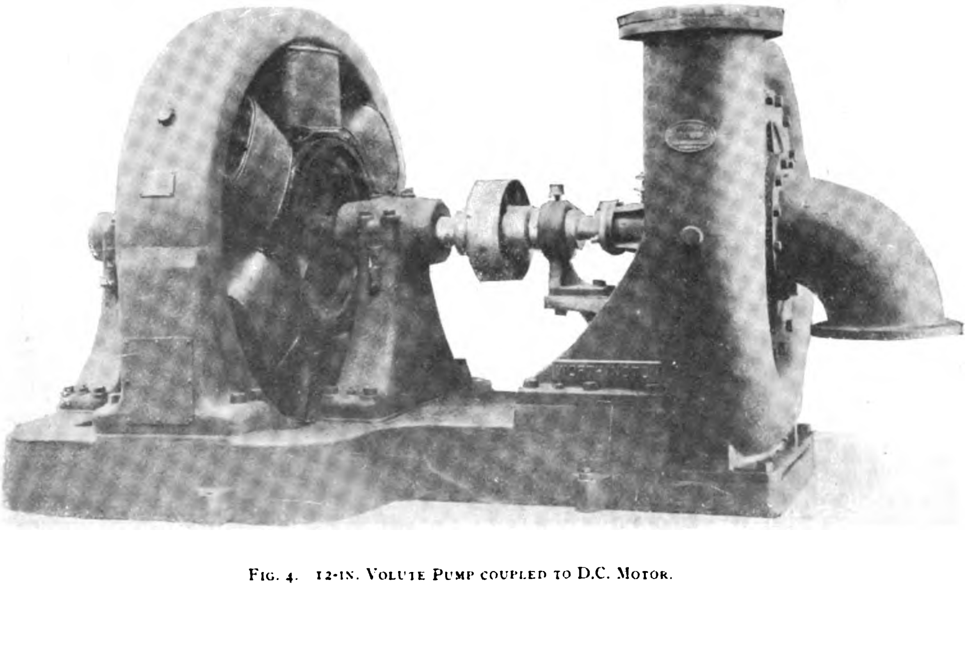


FIG. 4. 12-IN. VOLUTE PUMP COUPLED TO D.C. MOTOR.

and friction between the periphery of the rapidly revolving impeller and the slowly moving water in the discharge chamber.

The Worthington turbine pump is adapted to be driven by either an electric motor or a steam-engine, but the former is much preferable. Special motors are not required for direct-connected work, and it is possible to adapt the pumps to any motor of standard speed. Either direct or alternating-current motors can be used, and the pumps can be started against full delivery pressure without the use of special starting devices. Worthington turbines supply water for services where the average water pressure exceeds 125 pounds per square inch.

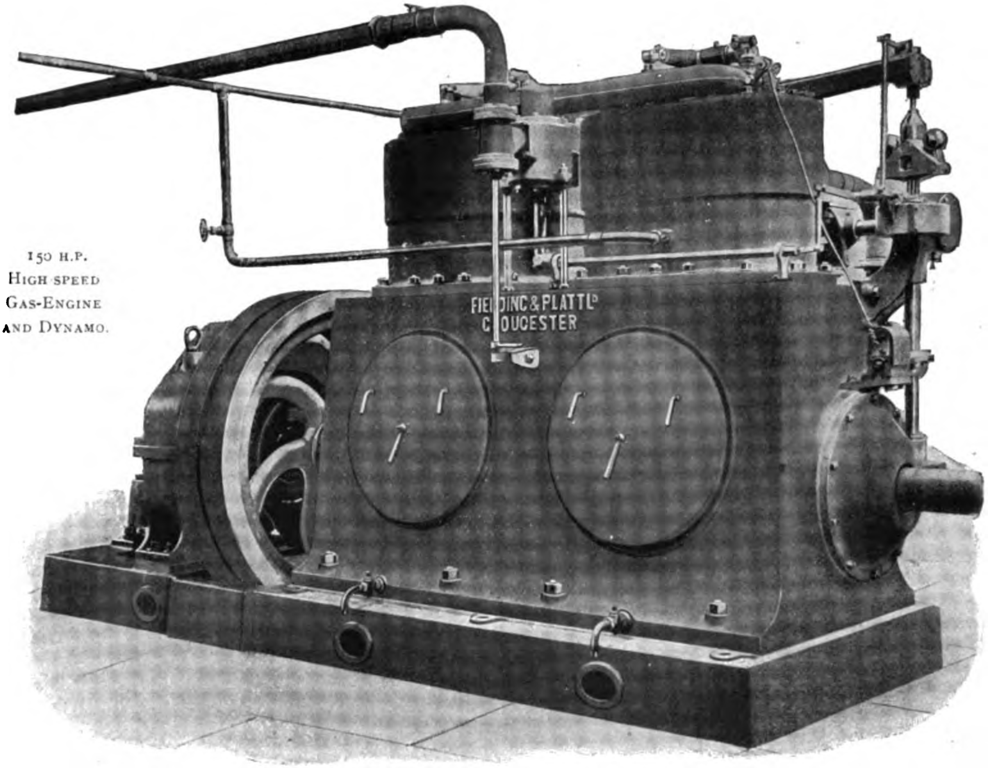
Fig. 3 shows twin 16-inch conoidal pumps specially adapted for low lifts and large deliveries. The pumps shown are driven by an induction motor. They deliver 5,000 gallons per minute against a twenty-feet head. One pump delivers water from a hot well to a cooling tower, while the other delivers cold water from a tower to the condenser. In the conoidal pump a special form of impeller is used, consisting of a double, conical shaped core, on which radial vanes are cast or mounted. The peculiar shape of this core serves to modify gradually the direction of the incoming current, thereby preventing sudden changes of velocity and direction whereby power is absorbed and wasted. The pump chamber or shell is divided into two equal parts by a radial diaphragm or partition, extending entirely around the interior of the chamber and enclosing the base of the conoidal impeller. This partition prevents the impingement and consequent disturbance of the two entering columns of water.

Fig. 4 shows a 12-inch volute pump, capable of supplying 3,000 gallons per minute to an elevated jet condenser. The head required varies between twenty-five and fifty feet. The new design of Worthington volute pumps embodies important improvements which enable them to work efficiently up to a head of eighty-five feet, and they have shown under test an economy of 86 per cent. It has been found possible to obtain a high efficiency at any head between fifteen feet and sixty-five feet without making the pumps either especially large or expensive. In the volute pump, because of the moderate heads and velocities, diffusion vanes may be dispensed with. The impeller is of the triple-vane type employed in the turbine pump.

Visitors to the Paris International Exhibition, 1900, will remember the Worthington Pavilion with its elaborate exhibit of pumping machinery at work, which was one of the outstanding features, so far as machinery was concerned. Their exhibit at the St. Louis World's Fair is even on a larger and more elaborate scale, and is certainly one of the main machinery features of this great exposition

A HIGH-SPEED GAS-ENGINE AND DYNAMO.

We have frequently referred to the importance of gas power for generating electrical energy, together with the desirability for an engine which could be coupled direct to the dynamo driven. So far this type of engine has only been found in the vertical form, which is more conducive to balanced running and general compactness. Experience with the steam-engine proved conclusively that the vertical engine alone could fill the requirements of a good high-speed engine for dynamo driving, and gas engineers are learning a similar lesson in their particular designs. We illustrate a type of gas-engine possessing many novel features, and likely to enter what will ultimately prove to be a wide field of utility. The general design of the engine will be gathered from the view of same given herewith, and reference to its makers, Messrs. Fielding and Platt, Gloucester, need only be made to vouch for the excellence of its arrangement and workmanship. It has four cylinders, each 13½" dia. by 15" stroke, the liners being in two pairs contained in a single water jacket. By this method simplicity itself is secured, and if necessary a two-cylinder engine can be made from the same patterns. The valves are plain mitre type, the inlets being inverted in the cylinder heads and the exhausts in boxes at the side, cast in one with the cylinder jacket. The exhaust valves are of cast iron and water jacketed. Cam and lever gear operate the valves, which are all readily accessible from the platform on one side of the engine. Starting is effected by direct pressure, the air being derived from a reservoir at a pressure of 150 lbs. to 200 lbs. per square inch, a small compressor serving to provide this. Several starts can be made from one full charge. One cylinder only is used for starting. Governing is obtained from a neat arrangement patented by Mr. Fielding. This comprises two superposed pistons, fixed at given distances on a special rod, the lower one carrying the air piston being hollow and permitting the rod for the gas piston to pass through it. Both pass through a common guide and terminate in holders filled with links attached at opposite sides to a disc which is revolvable about an axis by an adjusting screw. Movement of this screw tends to move the pistons to or from each other, so that when they are moved together by the governor rod the ratio of



150 H.P. HIGH SPEED GAS-ENGINE AND DYNAMO.

gas to air remains at the set quantity until further adjustment is made. This is an exceedingly neat device. Electric ignition is fitted a magneto furnishing the requisite current for the sparking plugs, while arrangements are made for advancing or retarding the spark. The governing, we are informed, is delicate enough to control the speed within 3 per cent. of normal when full load is suddenly thrown off. A fly-wheel 72" dia., weighing 50 cwt., is keyed to the shaft between the engine and dynamo, the latter a Mather and Platt machine. The running is so "sweet" that no movement of the volt-meter is perceptible.

Messrs. Fielding and Platt have also introduced a special engine and producer plant for isolated districts or any work where steam is now used. The generator which uses anthracite coal is automatic in action, requires small space, obviates risk of explosion and has low first cost. The cost of working, we are informed, does not exceed $\frac{1}{10}$*d.* per h.p. hour or 10 b.h.p. for 1*d.* per hour, and no skilled labour is required. We are sure that all users of gas plant will be interested in this gas producer and engine. For agricultural work it should fill a long-felt want especially in furnishing power for driving dynamos to light country houses.

A FIFTY-TON ELECTRIC CRANE.

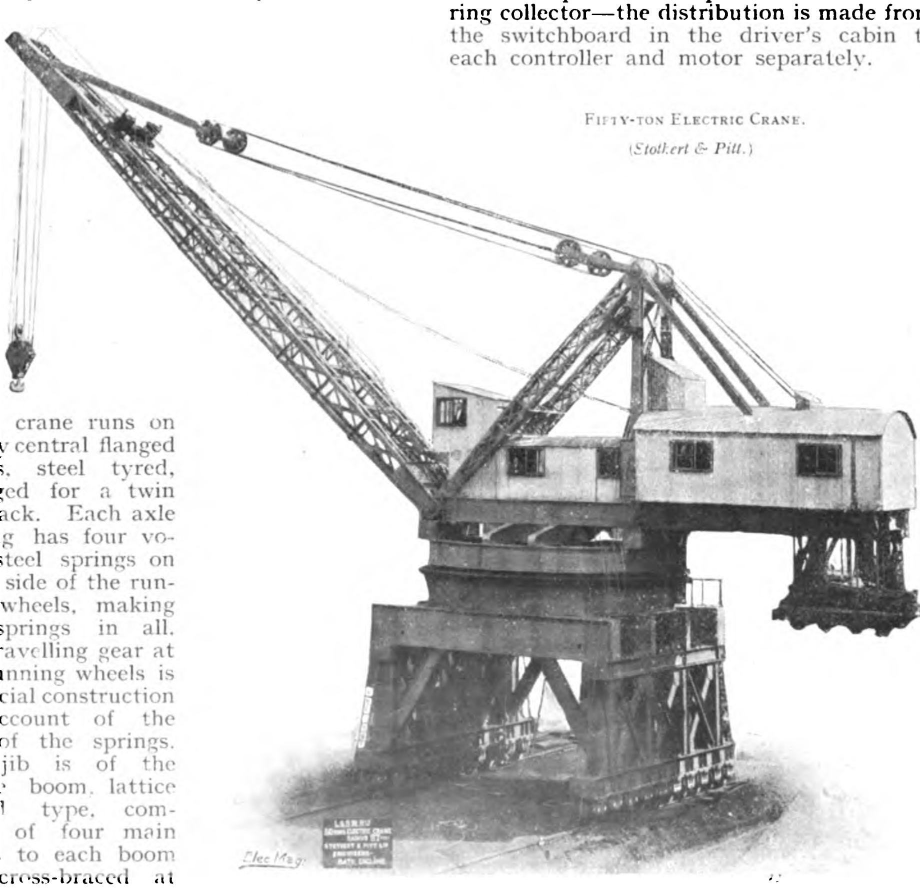
THE splendid example of electric crane shown herewith was designed and manufactured by Messrs. Stothert and Pitt, Ltd., of Bath, to the order of the London and South Western Rly. Co., for use at their new Graving Dock at Southampton. The electrical equipment was supplied by the Allgemeine Elektricitats Gesellschaft of Berlin. The crane was built under the supervision of Mr. D. Drummond, the Rly. Co.'s Engineer, and the electrical gear was inspected by Mr. J. G. W. Aldridge of 9 Victoria Street, London, S.W. The crane is electrically driven throughout by separate motors for each motion. The maximum radius of the crane for 50-ton loads is 87'0" at which radius the jib lies at an angle of 22° from the horizontal; the proof load at this radius is 70 tons. The derricking gear enables the jib to be raised —with the maximum load suspended—to a minimum radius of 47'0" at which radius the jib stands at an angle of 25° from the vertical.

The principal dimensions of the crane are as follows:

Gauge, rail centres . . .	25' 6"
Clear height under truck cross girders . . .	15 0'

Diameter of roller path .	25′ 6″ centres.
Wheel base . . .	30′ 0″
Length of jib . . .	81′ 6″ centres.
Height of jib-head at maximum radius . . .	60′ 0″
Height of jib-head at minimum radius . . .	103′ 0″
Radius to centre of tail ballast	32′ 0″
Height from rails to circular rack	23′ 0″
Height from rails to top of king post . . .	56′ 0″

controllers and resistances. On the upper part of the front of the house is built an elevated cabin for the driver, to which are brought all the operating levers. This arrangement gives a very extensive outlook for the driver in all directions, the cabin having windows on all four sides. Current is taken from the Company's ground boxes, by a length of cable to the junction fixed to the inside of the crane truck, from whence it is carried by cables up through the centre pin, on the top of which is a double ring collector—the distribution is made from the switchboard in the driver's cabin to each controller and motor separately.



FIFTY-TON ELECTRIC CRANE.

(*Stothert & Pitt.*)

The crane runs on twenty central flanged wheels, steel tyred, arranged for a twin rail track. Each axle bearing has four volute steel springs on either side of the running wheels, making 160 springs in all. The travelling gear at the running wheels is of special construction on account of the play of the springs. The jib is of the double boom, lattice braced type, composed of four main angles to each boom and cross-braced at ends and middle. The derricking ropes are twelve part, $5\frac{1}{2}''$ circumference, reeved double, two parts leading from the barrel which is grooved right and left hand. The lifting ropes are $4\frac{1}{2}''$ circumference, reeved double, two parts off the barrel which is also grooved right and left hand. These ropes have a factor of safety of eight times when dealing with the maximum load. The back part of the house encloses the lifting and derricking crabs, the centre part contains the slewing and travelling motors and gearing and the front part contains the

The motor equipment is as follows:

Two 50-BHP lifting motors arranged with series parallel control.
One 80-BHP derricking motor.
One 50-BHP travelling motor, and
One 25-BHP slewing motor.

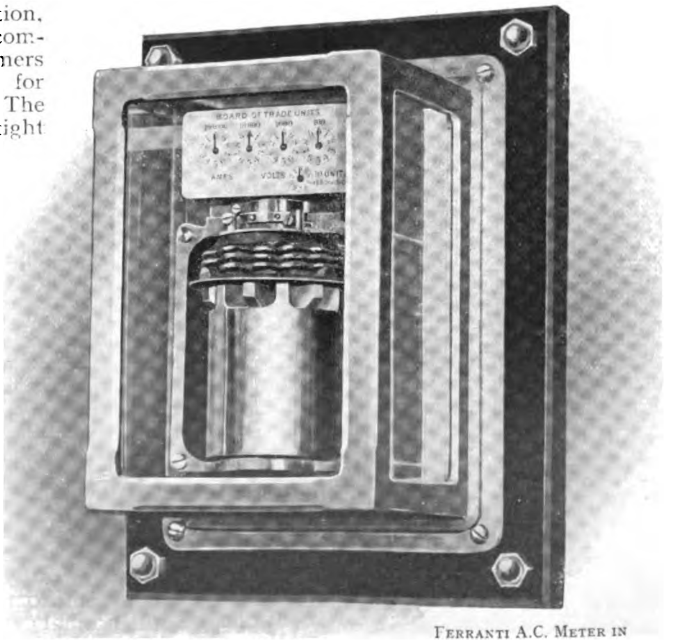
All the motors are of the enclosed type, series wound for 480 volts continuous current. The first and second gear reductions are all machine cut spur gear, except the first reduction of the derrick motion, for which a worm and worm wheel running

in an oil bath are used. There are magnetic brakes to the lifting and derricking gears, arranged in series with the motors, and connected up to the first notches of the controllers. In addition to these are provided a mechanical foot brake for lowering out loads, and a slewing brake. The derrick gear is provided with a special mechanical frictional resistance which comes into action when lowering out the jib. It is fitted on the end of the worm spindle, and is of the ratchet and pawl type, so arranged as to be automatically thrown out of gear when raising the jib and *vice versa*. The whole of the first reduction gears are enclosed and run in oil. The under carriage of the crane is constructed upon the lines of the maker's well-known Titan practice, and is strongly braced in all directions. The net weight of the crane is about 250 tons; ballast in concrete blocks 70 tons; making the weight of the crane in running order with load on about 375 tons.

FERRANTI INDUCTION WATTMETER.

SWITCHBOARD INSTRUMENTS AND TRANSFORMERS.

THE growth of remote control switch gears for H.T.A.C. currents has stimulated the demand for current and potential transformers to feed the L.T. instruments on the control boards. Messrs. Ferranti, Ltd., Hollinwood, Lancs., have recently introduced types of these which should prove valuable in this direction, seeing that they are very compact. The current transformers are made in sizes intended for 500 to 10,000 volt circuits. The 500 volt size is in water-tight C.I. tanks with cable terminals for bitumen sealing, a special chamber being provided for the purpose. They are designed with more margin of material so as to be specially suitable for use with integrating wattmeters, giving an absolutely constant ratio over the whole range. The average number of secondary ampere turns is 1,600. This particular size is made for primary currents up to 6,000 amps. A high tension size is also constructed for voltages between 2,500 and 10,000. In this case the primary terminals are brought through special insulating bushes at the top of the case. Above 5,000 volts the cases are oil filled. The transformers are vacuum dried and impregnated under pressure with insulating compound several times during manufacture. This size is made for primary currents up to 500 amps. A line of potential transformers for



FERRANTI A.C. METER IN SWITCHBOARD CASE.

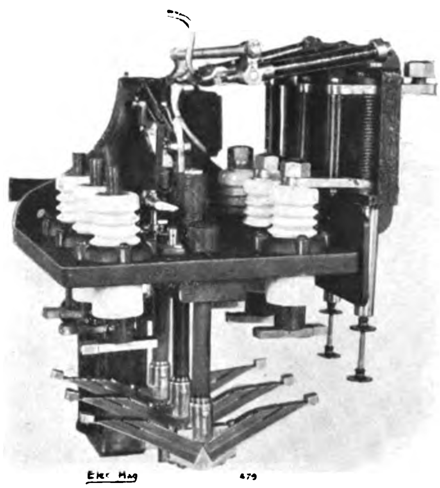
instrument use is another speciality of the firm, these being made in two classes; C, open type without cases, for potentials between 500 and 5,000 volts, and CC, closed type in water-tight C.I. cases for potentials between 500 and 30,000 volts. As great care is taken with these transformers as with the current type, the process of insulation being identical. A test pressure twice the normal is guaranteed, and three times this for one minute. The secondary is provided with means for earthing one terminal if desired. The transformers are quite suitable for synchronisers, the temperature rise not exceeding 50° F., after giving 150 watts for one hour.

A line of switchboard instruments is being introduced by the firm, for A.C. and D.C. circuits. The D.C. are D'Arsonval pattern with round case and dials. The A.C. are of the induction type. They are of exceedingly neat design, and would do credit to any switchgear. We illustrate a switch-board wattmeter in glass case, this being an A.C. metre of Messrs. Ferranti's latest pattern.

NEW AMERICAN HIGH-TENSION OIL SWITCHES.

In our February issue we gave some particulars of the oil break Switches of the Hartman Circuit Breaker Co., and we are now pleased to publish some additional data furnished by our American correspondent Mr. Frank C. Perkins.

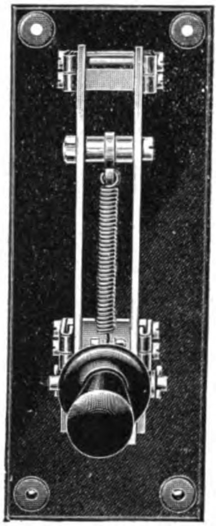
The accompanying illustration shows a new type of high potential oil circuit breaker, of the three-pole double-coil type and high-tension switch, for 400 amperes and 11,000 volts as constructed at Mansfield, Ohio, by the Hartman Circuit Breaker Co. Each pole of the switch is immersed in oil in a separate tank entirely independent of the adjacent one and readily removable without interfering with the others. Insulating material is used for lining the tanks and there is just sufficient space for the free vertical movement of the switches, so that a minimum quantity of oil is required. A laminated or brush form of contact is employed, thereby greatly increasing the current carrying capacity and preventing the sticking or freezing of the contacts, which are protected by final arcing plates which are removable. A very large breaking capacity is provided by separating the switches into different compartments and the form of contact employed. Wooden rods are used for controlling movable parts of the switch, the rods being fastened at their upper ends to a common cross-bar and they are held in moral position by means of a toggle-lock. The circuit breaker is provided for 400 amperes at pressures up to 11,000 with tripping coils in the two phases, either one of the tripping coils breaking all the lines. With the double-pole circuit breaker a single tripping coil is employed, although in some instances tripping coils are provided in each line in both the double pole and three-pole type. The coils are mounted on porcelain insulators and energised from the high potential circuit, being separated from each other by barriers of insulating material. By means of this design there are no current carrying parts in front of the switchboard and the necessity of using series transformers in connection with the circuit breaker is obviated, while it may be tripped by hand when desired, by turning the



11,000 VOLT 3-PHASE OIL SWITCH.

operating handle in the direction opposite to that taken in closing. The preliminary movement of the handle rod will carry the toggle which locks the circuit breaker past the dead centre, and the switches will then open free from the control of the operating handle. The circuit breaker is so designed that it cannot be held closed while an overload or short circuit exists on any phase of the line. The overload attachment is so arranged for example, that should the operator attempt to close the breaker while such conditions exist, the instant the arcing plates are brought in contact with the terminal, the solenoid will act and disconnect the switches from the operating handle. Before the breaker can be reset the handle must then be turned to the full open position. The open or closed condition of the breaker is indicated by the position of the handle on the front of the board and may also be indicated by different color lights. This oil circuit breaker has a range of adjustment of from 75 per cent. to 150 per cent. of the normal current and operates within 5 per cent. of the adjustment which is readily affected and very constant.

THE "CANTIE" SWITCH.

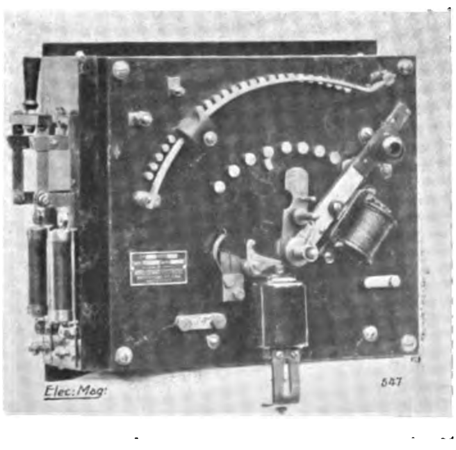


The Cantie Switch.

Marsh, Son & Co., Ltd., have brought out a type of knife switch for which they claim special features. With so many of these devices on the market it would seem difficult to effect further improvement, but judging by the design of the "Cantie" switch considerable advances over existing types have been made. The switch has a quick "make," an unusual feature of any switch, and it is stated that this device obviates much of the burning of contacts experienced with types unprovided with a quick make. In addition the switch arm has no intermediate position and cannot be placed other than on or off under normal working conditions. In both these positions the switch is effectively locked and the break is a very quick one. The switch is well adapted for motor service and works equally well either vertical or horizontal. It is made in sizes up to 500 amps., and in various forms.

A MOTOR STARTER AND REGULATOR.

The accompanying photograph shows a standard pattern of motor starter, made by Geipel and Lange, fitted with no-voltage release and maximum current circuit breaker, arranged with a means for regulation on the field. This type has mounted upon the side of the box a d.p. knife switch and d.p. fuses. The particular feature of this pattern is, that the resistance is inserted in the field by means of a small cursor moving along a quadrant bar over a row of contacts at the top of the panel. This cursor may be left in any position desired whilst the motor is running, but can only be moved from the position of full field after the motor has been started. In the event of the supply voltage failing and the no-voltage release operating, the contact arm, which is shown with a small handle for operation runs back over the contacts under the influence of a spring, thus opening the circuit. In running back it carries with it the cursor on the field quadrant, thus returning it to the full field position. Should the maximum current circuits act, thus bringing the arms into the positions shown on the photograph, the field cursor is also returned to the full field before the circuit can be again closed.



Motor Starter and Regulator.

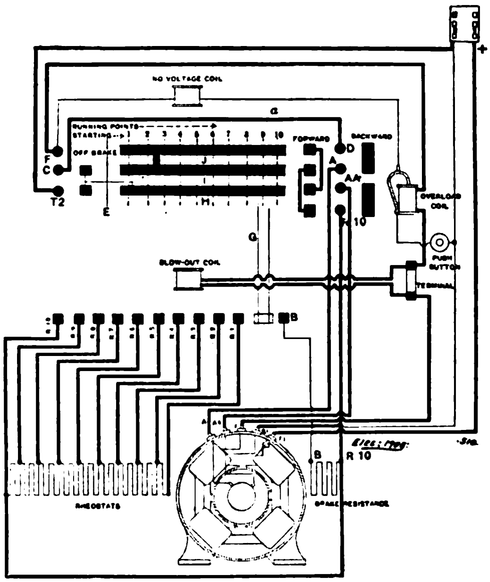
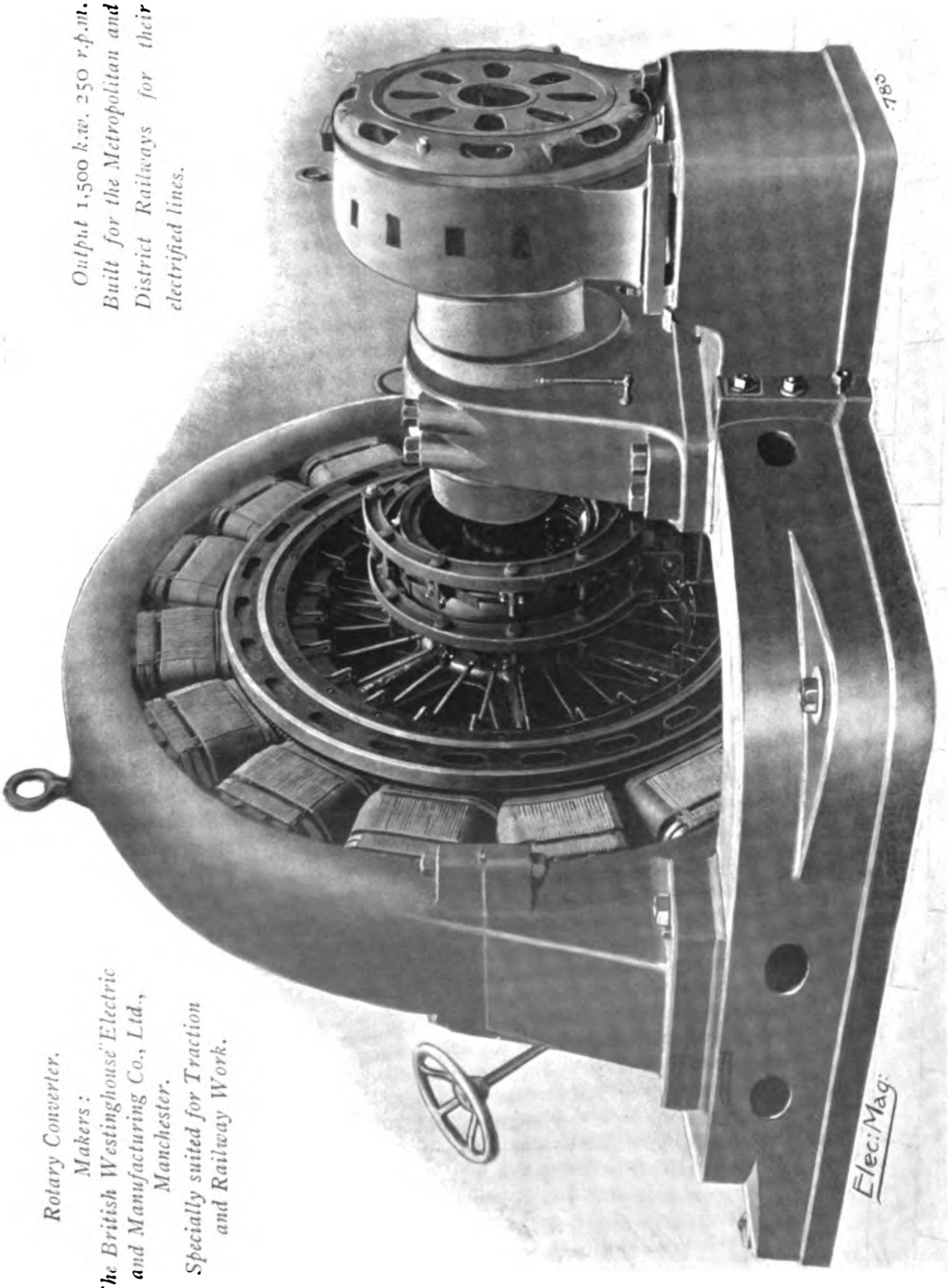


Diagram of Rheostatic Controller.

A RHEOSTATIC CONTROLLER.

The rheostat controller made by the General Electric Company is operated in the manner shown in the adjoining diagram. The brake resistance is so proportioned as to bring the armature to a state of rest as rapidly as it can without producing a shock. A no-voltage coil is provided and also an overload release. The last named magnet acts by opening the circuit through the coil of the no-voltage magnet, as clearly shown in the diagram. A push button is included in the no-voltage magnet coil circuit, so that by pressing this the motor may be stopped at any time without returning the controller handle to the off position.



Output 1,500 k.w. 250 r.p.m.
Built for the Metropolitan and District Railways for their electrified lines.

Rotary Converter.
Makers:
The British Westinghouse Electric and Manufacturing Co., Ltd., Manchester.
Specially suited for Traction and Railway Work.

Standard Types of Electrical Apparatus. III.

The World's Electrical Literature Section at end of Magazine contains a classified list of all articles of interest to Central Station men. Consult it and save yourself much valuable time.

"Faults" on Underground Mains: A Remedy.—III.

By JAMES CLEARY.

(Continued from page 194.)

THE efficiency of a net-work depends largely upon the design of the disconnecting - box, as much trouble in the past has been traced to defects in this direction. The majority of those now used are a splendid object - lesson in what to avoid in designing a *practical* box. The defects of the iron joint-box are often to be found here intensified. One box much used on extensive net-works has the old defect of pockets and slides, the latter extending nearly the whole length of the four sides of the box. The cables pass through a wood bush bored to *fit* them, the different poles being kept apart by small pieces of wood which can easily fall out of position. The cables are connected up with links. The lower part of the box is filled with stiff compound to above the level of the cables, and then the links, which are slightly higher, are, after bolting up, submerged in resin-oil. It is supposed that the stiff box-compound will keep the cables rigidly in position, and protect them from injury by moisture, &c., and also that when the links are removed it will give the cables sufficient support to keep them in place. The resin-oil is used because it is soft and renders the links accessible and also prevents " arcs " forming b tween poles. This box is a disappointment in every sense. The resin-oil unites with the compound, and forming a soft mass defeats the objects aimed at. One of the principal difficulties is experienced in obtaining good contact, this important feature being quite ignored. Another unpardonable defect is, that directly the links are taken off for any purpose the cables move out of position—the mixture not being stiff enough to support them. If they do not fall together and form a "short" this frequently happens when the workman, armed with box-spanners, &c., proceeds to connect up. The risks are enormous, and this system is fraught with constant trouble. Another type of box which has developed decided weaknesses is that with stuffing-boxes for cables to pass through. The least working of the cables upsets the packing, and allows moisture to pass, after which it is only a matter of time for a " fault " to develop. Here again there is no precaution against accidental " shorts " if a workman should let a tool slip whilst working inside the box. The consequences are generally laid at his door, when the real cause is to be found in the design of the box.

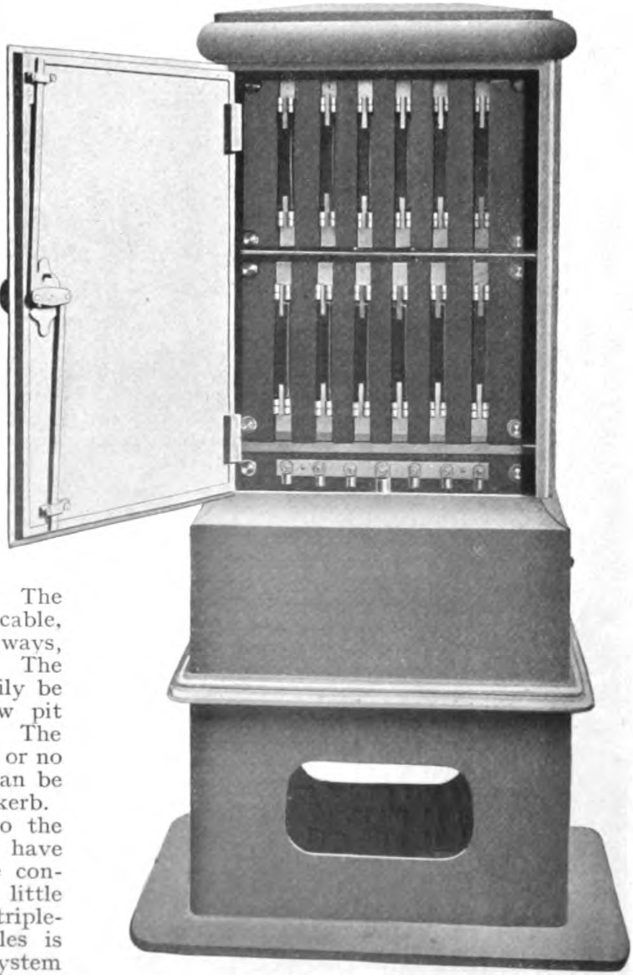
A disconnecting-box has been designed which has overcome all the above defects, and many others. Moisture risks are reduced to a minimum. All cables are wiped on to unions tapped into the box, and the cover has special features which make the box perfectly watertight. The contacts are all clean and visible, and easy of manipulation. Cables are rigidly supported, and *cannot move.* It is impossible for a workman to cause an accidental " short," even if he dropped *any* tool into the box. Insulation is high, and stands a pressure of 2,500 volts. The box has been well tried under working conditions, and has given complete satisfaction. It is adapted—without extra cost—to triple-concentric, three-core, or single cables, or, if necessary, a combination of the various types. The connections may be formed with links or fuses, if the latter are preferred there is a *uniform* gap of 3½ in., and provision is made to prevent " arcs " forming from one pole to another or to earth. No wood or

other inflammable material is used in the box, so that beads of molten metal usually formed when a fuse melts or blows cannot do any harm, and in the case of a "short" the box clears itself admirably. The designer claims to have overcome every known defect, and the results certainly justify that claim.

Many of the old defects are retained in some boxes because it is considered that they simplify the work of connecting up in the street. This applies more especially to the box with movable sides—absolutely the worst. This is no longer necessary, as the box can be made up quicker and more efficiently in the workshop, and afterwards connected up to the net-work by straight joints. Some may hastily condemn this method on the score of expense, but as efficiency is the primary aim it would be well to consider it from this standpoint first. By doing the work in the shop, the best workmen can always be employed on box-fitting, the work gets more direct supervision whilst in progress, it can be done quicker, neater, and easier on the bench than in a hole in the street, wet-weather risks are overcome, and if desirable the finished box can receive a pressure test before being connected to mains. It can be connected up on "live" cables in any position, and on *all* classes of cable. Each of these advantages is a distinct gain over the older methods. The straight joints being lead-wipes, like the box, are reliable, so that no weak points are introduced here. With regard to cost, the saving effected by making-up in the shop meets the cost of the straight joints, and the cost of the finished job compares favourably with any box with an equal number of ways. It is electrically and mechanically sound, and is suitable for large or small net-works. The fittings are made for all sizes of cable, and can be had for any number of ways, from two to eight ways and feeder. The box requires little room, and can easily be placed in any side-walk and shallow pit built with frame and box-cover. The side-walk can be made good with little or no obstruction, as the ends in the box can be left long enough to be jointed outside kerb.

Where conditions are favourable to the use of feeder-pillars, they certainly have many advantages, and providing the connections are well arranged they leave little to be desired. A pillar adapted for triple-concentric, three-core, or single cables is here shown. If used on the solid system the compound can be continued to the inside of base, so that the lead is not exposed. The fittings are well mounted on slate, which is bushed, thus ensuring good insulation. It is well ventilated, safe, and well adapted for the fusing of mains, the opposite poles are all separated, each being on a separate base. These pillars are a boon on scattered net-works, as one man on a bicycle can attend to them. They require little attention, and the cost of maintenance is slight, and many engineers have introduced them with satisfactory results.

Since the introduction of the higher voltages, the necessity for fusing mains has been more fully realised, and many engineers who were indifferent before are now convinced that the proper thing to do is to limit the risks of "shorts" by a system of fusing. The custom of burning out a "short" was a risky proceeding even



Pillar-Box with Door Open.

on the lower voltages, but the effect was slight compared with the havoc caused now on a 400- or 500-volt "short" on an unfused main. If the "faulty" cable should be of large sectional area, it is a fortunate circumstance indeed if the damage is confined to the cable itself. There are some cases where boxes are not adapted to fusing, and to introduce fuses would necessitate new boxes. The cost of such a change on a large system would be enormous, and on that account prohibitive, but even here a system of sectional fuses could be introduced with advantage First by halving the net-work, then dividing it into four, and so on, so that in time each feeder would be fused around its own area, and in the event of a "short" on the mains it would be limited to one feeder only. The feeder showing excess of current at station could be disconnected, and the fuses outside feeding the "faulty" area would blow and automatically throw the "faulty" section "dead." This section would be comparatively small, and the damage to cable, &c., much reduced.

Boxes designed for fusing on the lower voltage often give trouble when used for 400 volts and above, as, when a fuse blows, the "arc" being much longer "jumps" across to another pole or to earth, and generally before it clears itself does much damage to the box. This can be overcome by providing three safeguards. First, separate the poles by inserting slate or other suitable divisions; secondly, place slate bridges midway between the terminals of each fuse so that the fuse has to rise slightly to clear it. In the event of the fuse blowing this bridge will break the "arc." Thirdly, line all exposed parts of inside of box with a non-inflammable material, to prevent the "arc" getting to earth through the cover or sides of box. This latter is most important, as with the neutral "earthed" there is the risk of either outer causing a "short" in the case of a fuse blowing. A very efficient means of providing against this is to line exposed parts of box with vulcabeston. This is a good insulator, and does not readily absorb moisture. In addition, it is fireproof, and is easily fixed in position with a thin layer of any suitable compound.

This system of fusing is quite safe, and is much preferable to having the fuses submerged in resin-oil. The connections all being clean and visible, much time is saved in examining and replacing fuses. These suggestions refer more especially to boxes in use, as they can be applied in place, thereby prolonging the life of the box. For new work the boxes should be designed on the lines recommended above, as the efficiency of the method described is beyond question, and all the necessary safeguards are provided.

Having provided against the *known* causes of "faults," it is well to be prepared with an efficient test to cope with the "faults" arising from *unknown* causes. Fortunately, these are in the minority. The author will next describe a test for localising "faults" having the following advantages: it requires no galvanometer or battery, is absolutely independent of the resistance of the "fault," is equally efficient with or without through lead connection, can be applied inside ten minutes, and is *reliable*.

Notes on the Working of Centra Station Plant.—IV.

Steam-Pipe Losses. *By F. H. CORSON.*

Of late years great improvement has characterised the design of steam-pipe systems, and a modern plant with its short piping is a striking and pleasing contrast to the cumbersome and expensive systems of eight or ten years ago. The steam ring with its attendant multitude of valves and joints is giving way to the more common-sense method of taking the shortest cut with as little piping and as few valves under steam as possible. That the ring was ever seriously adopted was due to the rapid increase in steam-pressures, and also to some extent, perhaps, to the fact that the uncertainty of the electrical portion of the earlier generating stations gave an impression of insecurity to the whole, and led to the unnecessary duplication of every part of the plant, in the endeavour to ensure absolute continuity of supply. Now, when the reliability of electrical installations may be regarded as at least equal to that of most other branches of engineering, the need for such complications has passed, and simpler arrangements are the rule, although one occasionally hears of engineers specifying bewildering combinations of engines and boilers.

But while this improvement in the general design is admitted, many of the details, the correct arrangement of which is an essential to good working, have not received sufficient notice, and instances are frequent of systems otherwise well planned which are spoilt by the neglect of elementary principles with regard to drainage and expansion.

The numerous absurdities which are constantly met with in existing methods of pipe-drainage are the more obvious cases of this and are a testimony to the neglect or ignorance of sound engineering which are frequently brought to bear on the subject. The defects referred to generally take one or more of the following forms:

(*a*) Small drains are often screwed directly into the bottom of horizontal pipes and in many cases even project through the metal, making it

A. Main Steam-Pipe.
B. Steam-Pipe to Engine Throttle.
(*Arrows indicate direction of Flow of Steam.*)

Fig. 1.

impossible for the pipe ever to be entirely clear of water.

(*b*) The drainage water is not always taken off at the lowest point of the steam main.

(*c*) The flow of the condensed water is often in the opposite direction to that of the steam, producing likelihood of water hammer actions.

(*d*) Steam pipes are laid with no fall in either direction to facilitate the natural flow of the drainage.

Another error in drainage is the over-zealous provision of unnecessary apparatus, which, while certainly achieving the object, does so at the cost of needless initial and current expense. Such a case is indicated in the first two illustrations (Figs. 1, 2). Here a steam-dryer is placed immediately before the engine separator, although the engine steam-pipe is in one case taken from the top of the steam-main, and it is interesting to note that the water-holding capacity of the dryer is some two gallons, while that of the engine separator is not less than twenty. Many other examples of a similar nature could be cited, the uselessness of which is so obvious as to render them hardly worthy of mention were it not for the frequency with which they are encountered in existing plants and specified in new schemes.

The design of a steam-pipe system which shall be simple, cheap, and thoroughly efficient is worthy of a more scientific treatment. The broad lines on which all arrangements should be based imply as principal considerations :

i. The absence of all unnecessary joints.
ii. Simplicity and shortness of piping.
iii. The use of as few valves as possible.
iv. The avoidance of sharp bends.
v. Efficient means of drainage, and
vi. Adequate but not wasteful provision for expansion and contraction.

With regard to simplicity, the second illustration (Fig. 2) is interesting as showing what to avoid and is a good example of a tortuous arrangement which might easily and with advantage have been replaced by two simple pipes. At the same time the desire to reduce the piping to a minimum may, if unintelligently applied, be productive of trouble in another direction. If the pipes be so small that there is no provision for reserve of steam the pulsations of the engine will be reproduced in them, quickly breaking the joints, if no more serious effects appear. Difficult corners and quick bends have been the causes of many accidents. Apart from the consideration of friction which is augmented greatly by the introduction of sharp turns, there is the increased risk of fracture of pipes and joints in event of any priming or condensation water being swept along by the steam. The occurrence of this should be prevented as far as possible by making the drainage pockets nearly the full diameter of the pipe, thus ensuring the rapid removal of any water, and by taking suitable precautions to minimise the condensation. This latter is a point to which

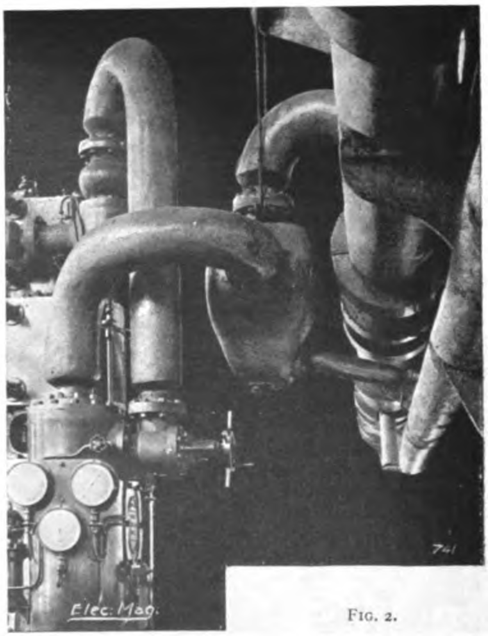


Fig. 2.

attention should be specially directed where coal is such an important question as it is in central station work, and there can be no doubt that the condensation of steam in the pipes is to be held largely responsible for the fact that the best central station figures show some 5 lbs. of coal used per unit sold, while a consumption of 10 lbs. is common. In order to find out approximately what amount of the steam raised was lost in this way, the writer has made careful tests of the plant in two stations of some 7,000 h.p. each. The water evaporated per unit generated at various times of the day, and under various conditions of load on the station, was made the basis of the investigations. The average results obtained were about 28 to 30 lbs. per unit during the evening load-shift, some 45 lbs. during the daytime, and from 70 to 80 lbs. during the night time. In a station of this size, it is fair to assume that the plant used could be run at approximately the same efficiency at all times, and the difference in the figures represents fairly accurately the extent of the condensation. The methods of treating this important question are primarily the reduction of the evil by good design of pipes, as before indicated, and also by thorough lagging, and secondarily, the most efficient disposal and use of such water of condensation, the occurrence of which cannot be avoided. The first and most obvious means of prevention to be employed is efficient covering, and it is curious to note that while particulars of the condensation taking place in uncovered or partially covered pipes are accessible on every hand, it is a matter very frequently neglected. The practice of leaving the joints and a few inches of the pipe on either side of them uncovered is not to be commended, and it is much better to carry the covering right up to the joint itself. It is so simple a matter to cut away the lagging to obtain access to the joints and to re-lag again when finished as to make it decidedly false economy to endure the constant condensation loss due to the partially uncovered pipes, with a view of easily working on the bolts, &c.

A great deal of time and ingenuity have been devoted to methods of utilising condensation water to the best advantage, and this is undoubtedly an important matter. It cannot be too strongly insisted, however, that only a part and a comparatively small part of the heat lost in the act of condensation can be retained by *any* means of drainage, and that the prevention of condensation is the first consideration. An example will illustrate this. Assuming a feed-tank temperature of 100° F., 1 lb. of dry, saturated steam at 150 lbs. absolute pressure contains some 1,120 units of heat. In condensing to water at the same temperature, some 860 units are given out and lost, leaving about 260, which it would be possible to save by returning the water direct to the boiler, showing that with an absolutely perfect system of drainage at least 70 per cent. of the heat must be lost.

It is only when all profitable preventive measures have been taken that the question of the best disposal of the condensation water arises. In some cases the discharge of the steam-drains is allowed to run to waste, a method only justifiable where the condensation is very small. The usual proceeding is to turn the drains into the feed-tank so as to utilise the heat which remains in the water. Where the amount of piping under steam is large it is distinctly worth while to retain as much of this heat as possible by returning the water immediately to the boilers by some system of gravity-return, rather than through traps to the feed-tank. The water is thus removed immediately it is formed and when it is practically at boiler temperature, while the employment of steam-traps implies its cooling, the expansion-trap, in fact, depending for its action upon the loss of heat in the water. By making a few simple tests to find out the amount of water discharged per hour from the traps, it is very easy to decide on the best means to be adopted and

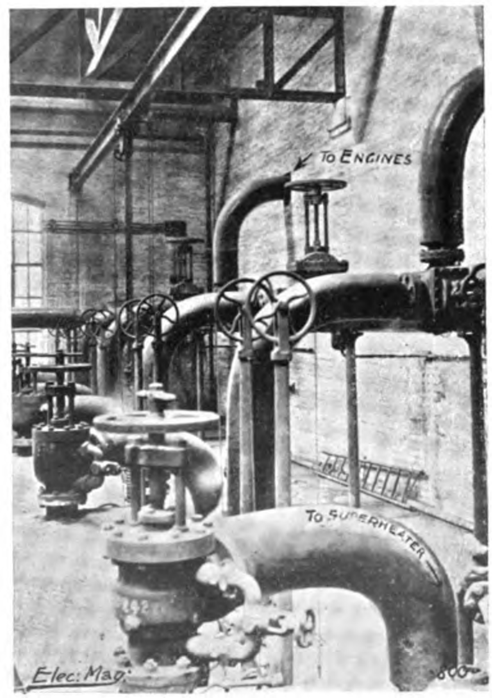


Fig. 3. Arrangement of Steam-Piping in Boiler-House.

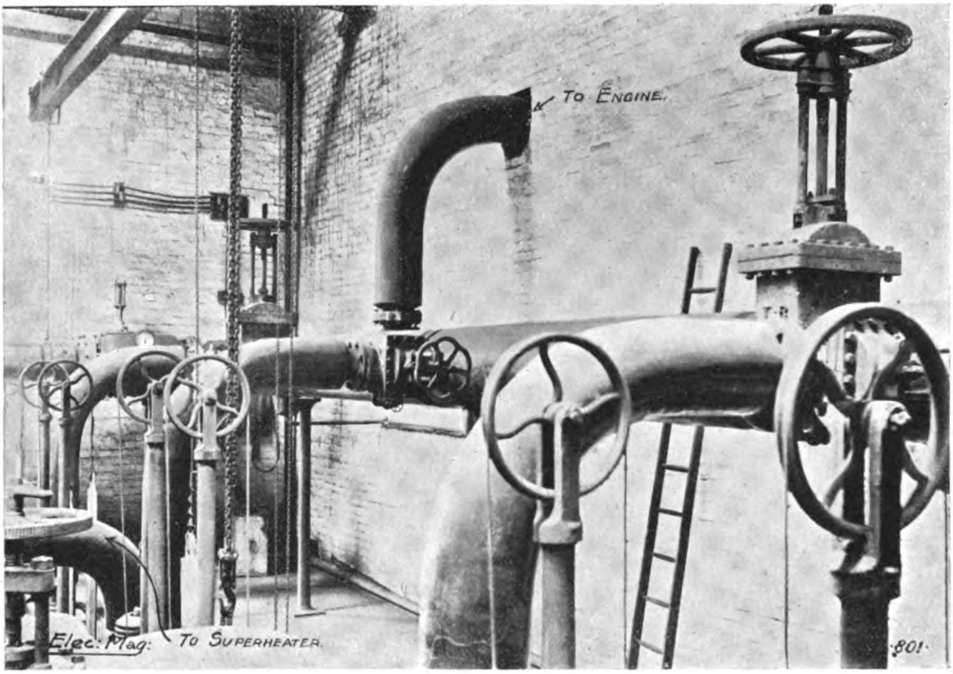


FIG. 4. BOILER-HOUSE, ARRANGEMENT OF STEAM-PIPING.

the probable saving to be effected by them. It is safe to say that in most cases the results of such tests will prove a very unpleasant surprise, as the amount of loss which takes place even with the best designed pipe systems is usually greatly under-estimated. It will be seen that the steam-piping must take the responsibility for a great deal of the discrepancy which occurs between figures from ordinary running of station plant and those obtained on test with as little piping as possible between engine and boilers. An arrangement of steam-pipes which has given excellent results in every way is that shown in the last two illustrations Figs. 3, 4. One main steam-pipe is provided, a small branch coming from each boiler and a relatively larger one going to each engine. This main pipe is set some distance back from the boilers so that very little provision is necessary for expansion, which is taken up by the spring in the connecting-pipes. It will be seen that :

(*a*) The pockets for drainage water are large enough to ensure the dryness of the pipes ;

(*b*) The steam main is of such dimensions as to hold a fair reserve of steam ;

(*c*) The connecting pipes to the engine are direct and of ample size, thus preventing any pulsations of steam being felt on the main range ;

(*d*) The arrangement is that which introduces a minimum number of joints and valves.

The objection which will be raised in many minds to such an arrangement is the impossibility of making any joint which may fail without disturbing the running of the plant, but it should be remembered that the very simplicity of the system reduces the likelihood of failure, and the writer is of opinion that it is far better engineering to take the risk of such a contingency than to accept the alternative with its constant and inevitable all day and night losses.

Switchboard Attendants.

By a POWER-HOUSE ENGINEER.

THERE are not wanting signs that the design of central stations for the supply of electric light and power is emerging from the experimental stage to one where known rules predetermine almost exactly the best composition and arrangement of each power-house for its work. For example we have the able paper recently read before the Institution of Electrical Engineers on Power Station Design ; again, a mighty war has lately been waged between the advocates of flat-back and cellular switchboards—a conflict of the standard Continental and English types. This process of standardisation has perhaps been carried further in the construction of the switchboard than in any other part of the power-house. Given the nature of the supply—whether by wire

direct—or three-phase high-tension currents one can foretell the general arrangement of the board. The switch-gear is the point of focus of the whole station, and it is at this point that the process of selection and rejection has proceeded with the greatest rapidity, because of the disastrous effects of a switchboard breakdown.

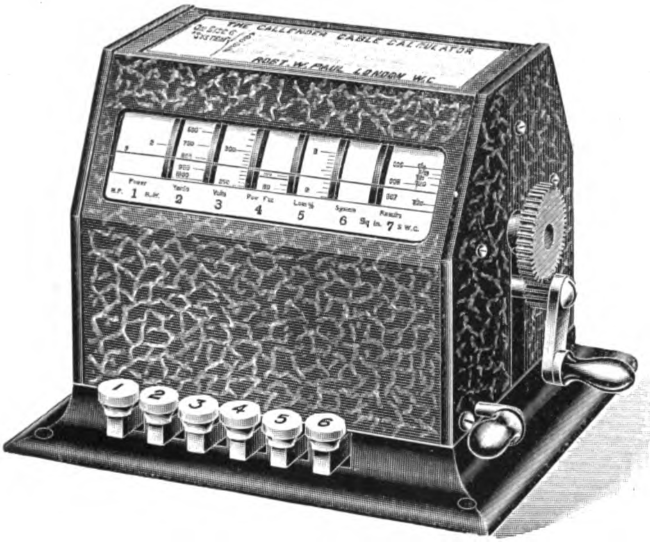
Given, then, that our switch-gear arrangements are now in a fairly "cut-and-dried" condition, the question arises as to whether we have the right men to work them. In former times initiative and technical knowledge were essential. While new combinations of controlling apparatus were being tried, no one knew what a switchboard would do next. The only thing certain was that something would happen usually very suddenly. To meet that something smartly, to get over the difficulty, often by a new route, were the functions of the switchboard attendant. Nowadays, the element of unreliability has been almost eliminated. Experience—sometimes very dearly bought—has shown what are safe constructions, and the work required on the modern switchboard consists of a few simple mechanical operations, the keeping of records, and clear-headed adherence to rule in case of breakdown. How much this is the case is shown by the fact that in some of the smaller two-wire power stations (the direct current type of plant being in more general use and therefore most standardised) the duties of switchboard attendant and engine driver are combined, under the supervision of an engineer-in-charge, who is also responsible for the boiler-house.

Hitherto the type of man most commonly found on the switchboard has been the college-bred, gentlemanly fellow who is not there for the twenty-five or thirty shillings a week which he is paid, but for the hope that is in him that one day he will develop into a shift engineer. This was exactly the man wanted when switch-board breakdowns were distressingly frequent and when it was necessary to have a good technical man, at as bad a salary as practicable, constantly on the spot. There are, however, certain ailings inherent to this type of man which ender him very far from being the ideal witchboard attendant: he has not been used to manual labour, polishing bright work to him a necessary evil—very necessary, but very evil; he sweeps the switchboard floor with an expression of resignation appropriate to an early Christian martyr. He is not accustomed to monotony, voltage-regulation "bores" him; directly he has obtained such local knowledge as is necessary to make him efficient for the job, he begins to lose interest in the proceedings and does his work perfunctorily—he has been so used to working in order to acquire knowledge that he cannot get into the way of working for work's sake. Moreover, he knows theoretically much more than is necessary for his job. The knowledge that is his makes him dissatisfied with the menial character of his work, and he is perpetually answering advertisements of fresh places, his thoughts being centred, not on his present employment but in his prospects of change. Even if we reconcile ourselves to the constant influx of assistants we are confronted with the fact that there are not vacancies enough to satisfy youthful ambition. For every successful applicant there are fifty malcontents. We are reduced then, to retaining in our stations men who are discontented with their employment, whose aim is not to make their work creditable to themselves, but to escape from it as soon as possible to gain fresh experience.

The remedy, which has already been tried in several power-houses with success, is to employ exclusively men of the artisan class to mind the board. The qualifications necessary are strict attention to duty, a capacity for doing exactly as they are told, and a cool head to follow out previously given instructions in case of trouble. Such electrical knowledge as they require can be imparted to them by the engineer-in-charge, in exactly the same way, and very much to the same extent, that the driver of an electrical tram is taught to make simple adjustments and repairs. Men of this description are used to hard work, and have no objection to keeping the place clean. It is shown by experience that they can be trained to cope with all ordinary incidents of running; they are more amenable to discipline, and they are not perpetually moving. An artisan is getting a fair wage when he receives thirty shillings a week, not an exorbitant sum for fifty-six hours of switchboard tending. He is, therefore, more inclined to settle down for five or six years and put in some good steady work than the youth who is haunted with the dream of five hundred a year and clean hands.

THE CALLENDER CABLE CALCULATOR.

A one time many engineers were prone to worry themselves with calculations taking up much valuable time. Now their troubles are at least minimised if not obviated by the Callender Cable Calculator, which is a handy apparatus designed by Mr. H. Hastings, M.I.E.E., A.M.I.C.E., for the purpose of easily determining the size of the conductor which should be used under any given conditions. It is made up of a series of discs mounted upon a common spindle, each having a logarithmic scale upon its periphery. There are six factors



THE CALLENDER CABLE CALCULATOR.

which determine the size of the cable, viz.:

(1) Power.
(2) Distance.
(3) Difference of potential.
(4) Power factor.
(5) The loss per cent. allowed.
(6) System of transmission employed.

In the machine each of these factors is represented by a disc; and a seventh disc accumulates the algebraical sum of the other discs on a simple mechanism. Thus if the discs representing the various factors are moved only the numbers upon them correspond with the data, but the seventh disc will immediately give the size of cable required to correspond with that data. An addition to the mechanism makes it possible to return all the discs to their starting position, ready for a new calculation, by a simple movement. The power scale is graduated both in kilowatts and horse power, and its range is from 1 to 1,000 kw. The distance is graduated in yards from ten up to 10,000, and the volts are from 100 up to 10,000, and the results are given in square inches and in S.W.G.

The following systems of transmission have been dealt with:

2-wire continuous current and single phase alternating.
3-wire continuous current single phase alternating.
2-phase with 4 conductors.
2-phase with three conductors, giving the size of the common conductor.
3-phase mesh or star both 3 wire and 4 wire.

It is enclosed in a well-finished case suitable for standing upon an office desk, and measuring about 6″ by 6½″ by 4½″ high. The scope of the machine is a very wide one, and it is made by R. W. Paul, 68 High Holborn, London, E.C.

NEW AUTOMATIC CUT-OUT.

FIG. 1 is a diagrammatic illustration of a new apparatus termed the "A. Périé de St. André" circuit-breaker. The common practice in electrical plants, especially for tramway lines, is to run the feeder direct from the central station (Fig. 1) SC to the line conductor CD. When this new instrument is used, feeder E is in two parts, which terminate at contacts *c* and *d* respectively. When the current is first switched on, lever *b* presses on contacts *e* and *f*, and lever *a* takes position *s*. Magnet B, which receives current from a wire *h* shunted on feeder E and earthed through wire *n*, contact *f*, lever *b*, contact *e*, and wire *m*, attracts lever *e*, which brushes on *g* as it shifts its position from *s* to *x*. As lever *a* is connected to *h*, current will flow momentarily on line CD through *h*, *a*, *g*, and *k*. Further, at end D of section CD of line conductor (the line being cut up in several consecutive and isolated sections) a thin wire *p* is shunted, through which the current flows into a magnet A and thence to earth through *m*. Magnet A attracts *b* which disconnects contacts *ef*, and opens the circuit containing magnet B. Lever *g* actuated by a spring resumes its position *s*, and lever *b* connect up contacts *cd* and closes circuit on feeder E. From this moment the current generated at the central station flows constantly through CD and returns by *p*, A, *m*, and the earth. Suppose, now, the line breaks at any point of CD. Then the inflowing current through *c* cannot reach magnet A, lever *b* falls and cuts the line out of circuit. Each end of CD can then be handled with perfect impunity.

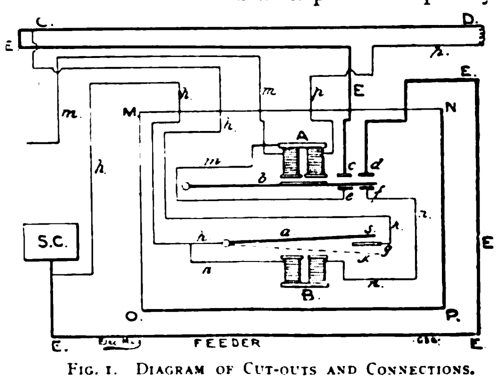


FIG. 1. DIAGRAM OF CUT-OUTS AND CONNECTIONS.

Electrical artisans should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles on subjects of importance to themselves.

Municipal Enterprise and Workmen.

By S. A. CURZON.

Now that municipal electrical undertakings are becoming so prolific, it would, perhaps, not be amiss to consider how they have affected the mechanic. When electrical work was entirely in the hands of private individuals or joint-stock companies, one feature, which has since certainly not operated in our favour, never appeared. Taking the lists of tenders accepted, we find that, notwithstanding the usual clause in the invitation to tender, the lowest price is the one to secure the work. Granted that better management and more up-to-date appliances enable one firm to quote lower prices than another, yet the large difference in the various tenders cannot be accounted for in this way. Rather is it the increasing anxiety exhibited by many firms to secure work at the closest margin of profit. which must, in the long run, recoil on the head of the mechanic. The manufacturer cannot lower the price of material nor the standard of his wares, so perforce the artisan has to suffer, if not on the individual job, on the subsequent work that the firm may carry out. The constant acceptance of low tenders by borough engineers and their committees is, perhaps, a matter more in keeping with other sections of this Magazine, but its bearing on the wages of the mechanic must not be forgotten.

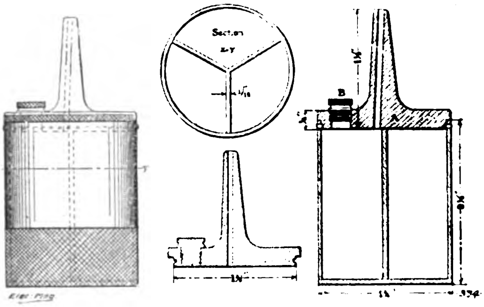
With any enterprise entirely in the hands of private individuals a tender is not always accepted because it is low. For one thing there is not the fear of the local ratepayers association. Shareholders are, as a general rule, more amenable to reason. Then where men are employed by Corporations, the wages paid are not so high as those which can be obtained by the individual outside. That mechanics are not so badly treated in this matter as some of their superiors is a regrettable fact. Men whose theoretical studies have cost a considerable amount of money are receiving less in the way of salary than those who are working under them. Nevertheless the mechanic is not getting as much from his municipal masters as his *confrère* is obtaining from a private firm. Neither is the experience to be gained in such berths the same, as the majority of them run in one rut, until perhaps there is a change in the head of affairs. Jointers, fitters, &c., are advertised for at a price that makes one shudder. At their best it is only the amount obtained by a very ordinary hand at the bottom of the trade. Many jointers, for instance, when completing a cable contract who are invited to stop and serve the municipality either have a struggle to obtain their ordinary wages or have to refuse the proffered berth owing to the cheeseparing proclivities of a committee. Another point to be considered is the obsolete "fair wages clause." That this is a dead letter is pretty well known. Very few engineers or clerks of works take the trouble to inquire into the wages being paid and even if they did it is easily overcome by describing the low-paid men as assistants or the employment of a number of improvers who are put to do the work of the ordinary electrician. The close-cut tendering encouraged by municipalities does not allow of full wages being paid and the quality of the work done cannot be as it should.

*AN EMERY SHAKER.**

I will describe an emery shaker that I designed and found to be a very convenient and useful addition to the tool-room outfit, as it dispenses with the numerous dishes,

* *American Machinist.*

cans, and packages generally used to hold the various grades of emery required in lapping and polishing. I made the model from solid brass, with three compartments, which I find most suitable for general work, although the device can be divided into six compartments if preferred. The partitions were cut from sheet brass and soldered in place; the body can be made from tubing, but a casting is better. The cap must be a good fit to prevent emery from passing the partitions. The stem is drilled out of line at the base, to clear the partitions so that by turning the cap A each compartment in turn will be free to discharge the emery while the other compartments are closed. Plug B can be dispensed with, although it is convenient when refilling, as it saves the trouble of removing the cap. Outside the compart-

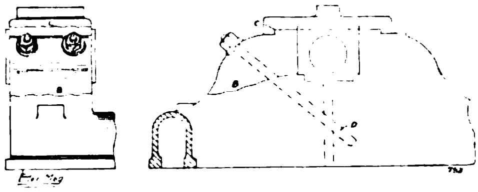


An Emery Shaker.

ments should be stamped the letters F, for fine; M, medium; C, coarse; and the cap should be graduated to indicate when it is in the right position to discharge, or when closed by stopping over partitions.

REPAIRING A BROKEN ENGINE BED.

The sketches show the pedestal end of a 250-h.p. Corliss engine bed, used for driving some weaving machinery and a large dynamo. In the engine-driver's absence the governors got "stuck" and failed to act, with the result that the engine "raced" and threw the fly-wheel to atoms, wrecking the engine-house and doing enormous damage, happily without loss of life. The front end of the bed from the crank shaft pedestal was broken completely off as shown by the line B, breaking the cast-iron pedestal cap as shown at C. The cost of a new engine bed was a serious item, so after a consultation we decided on the repair shown. We drilled two holes $2\frac{1}{4}$ in. diameter in the front portion of the bed end which was broken off as shown, and two more of the same size in a line through the strengthening rib in the box bed under the centre of bearing as shown. We then



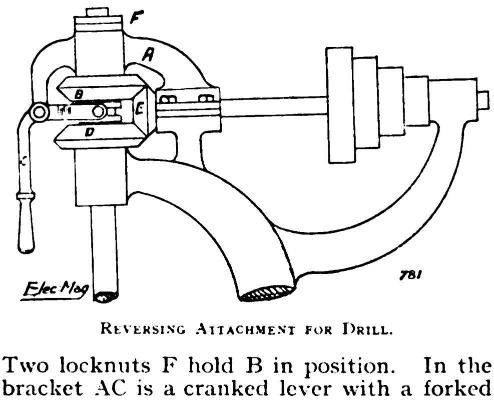
Repairing Broken Engine Bed.

drilled some $\frac{1}{2}$-in. holes in each side and chipped them into cotter holes as shown at D, and put two 2-in. bolts through and passed a cotter through them both at the bottom end, and screwed the nuts tight up. We replaced the cast-iron cap with a new wrought-iron one, and thus completed the job. The engine has been running eight years since, and shows no signs of weakness.

Swift.

REVERSING ATTACHMENT FOR DRILLING MACHINE.

Frequently having large quantities of brass terminal blocks and other small electrical goods to tap, we added a reversing motion to an American drilling machine as shown, which enabled us to tap them in the drill. We have had it in use three years now, and it answers perfectly. A is a cast-iron bracket which takes the place of the top cap of shaft bearing as shown. B is a bevil wheel with a sleeve on the gear, being the same as D, they both gear in the pinion E.



Reversing Attachment for Drill.

Two locknuts F hold B in position. In the bracket AC is a cranked lever with a forked end operating the double-faced clutch which engages with both the wheels—one at a time—as the operator moves the lever. The clutch carries a key which slides in the keybed of drill spindle, the wheels being loose.

Swift.

Every electrical artisan should have the first volume of "The Electrical Magazine" in his possession. Send your order at once or you will be too late.

ELECTRICAL TRADE and COMMERCE

Trade and Commerce Articles of the month are classified under the World's Electrical Literature Section at end of Magazine.

The Utilisation of Water Power.

By W. NOBLE TWELVETREES, M.I.Mech.E., A.M.I.E.E.

We have referred in a previous issue of *The Electrical Magazine* to the desirability of using all available sources of power in the United Kingdom for the generation of electricity. As our readers are probably aware the only instance of a large hydraulic electricity plant now at work in the British Isles is the installation of the British Aluminium Company at Foyers. This, at the present time, gives a total output of 7,000 horse-power, but additional machinery on the point of completion will raise the capacity of the works to 9,000 horse-power. Another undertaking of similar character is now being developed in Wales, by the North Wales Electric Power Company, the scheme having been prepared by Messrs. Bennett and Ward-Thomas, of Manchester. The history of this project is interesting, and serves to indicate the advantages that may be obtained by intelligent appreciation of the possibilities offered in districts where commercial enterprise has been almost entirely lacking. It appears that in 1900, Mr. F. F. Bennett, M.I.E.E., of the above-mentioned firm, was approached by some gentlemen in Portmadoc with the request that he would report upon a proposed scheme for a light railway from the town to Beddgellert. After inspection of the district, however, Mr. Bennett came to the conclusion that the line was not likely to prove remunerative. Further study of the district suggested that Lake Llydaw, about half-way up Snowdon, was quite able to furnish 1,000 horse-power, and that the construction of a dam at one end would very largely increase the power to be obtained from this lake. It was also ascertained that several abandoned slate quarries existed in the neighbourhood, which had been closed because the cost of cartage to Portmadoc precluded successful competition with the quarries at Festiniog, where railway facilities prevailed. The idea then struck Mr. Bennett, that if Lake Llydaw could be harnessed and a narrow gauge railway built to Portmadoc, these quarries could be remuneratively reopened, and, at the same time, the desired establishment of railway transport between Portmadoc and Beddgellert would be commercially practicable. The complete scheme as formulated by Messrs. Bennett and Ward-Thomas, included the purchase of the Croeser horse railway between Portmadoc and Lake Gwynant, and proposals for the electric lighting of Portmadoc, Beddgellert, and Criccieth. Parliamentary sanction was obtained in the Session of 1901, and the works are now under construction. Lake Llydaw, on the eastern slope of Snowdon at an elevation of about 1,418 ft., is over a mile long and averages about one-sixth of a mile wide, the area being 5½ million square feet. The watershed, covering 47 million square feet, includes Lake Glaslyn and the upper portions of the Snowdon range. The rainfall in the Llydaw catchment area is phenomenally high, being, according to "British Rainfall," 193½ in. for 1900, and 169 in. for 1901, and, what is still more important, the rainfall is well distributed throughout the year. For the development of power, it is proposed to construct a dam about 150 ft. long, and of such proportions as to raise the level of the lake by 20 ft., and owing to the configuration of the ground it will be easy to draw off water at 30 ft. below its present level, or 50 ft. below the level proposed. This will give a storage equal to at least 250 million cubic feet. The site for the power-house is at a point 1,200 ft. below the lake, with which it will be connected by two steel pipe lines. Mr. Bennett estimates that the impounded water will provide ample storage to provide 6,000 horse-power for ninety days, quite independent of any rainfall or of supplies from permanent streams during the same period. The first installation at the generating station will consist of four 1,000 kilowatt sets, each consisting

of a double-tangential waterwheel coupled to a three-phase alternator, giving 11,000 volts at forty periods per second. The writer has recently had an opportunity of inspecting the whole of the district that will be covered by the operations of the undertaking and consequently is able to confirm by personal observation the sanguine hopes that are entertained as to the success of the projected power-station and electric railway. Beyond the abandoned quarries, there are various mines in the Snowdon district that may be reopened, and once more restored to prosperity, and it is quite certain that visitors to the different holiday resorts, and tourists proceeding from place to place, will gladly avail themselves of the passenger service which it is proposed to establish on the new line. Another installation is contemplated by the North Wales Electric Power Company in the Conway Valley, where fully 12,000 horse-power can be made available for the supply of energy throughout a large area of the counties of Carnarvon, Merioneth, and Anglesey. In Scotland, a proposal has recently been made to develop a scheme in connection with Loch Sloy, some five miles north of Tarbet, between Loch Long and Loch Lomond. A dam at the eastern end of the loch will impound nearly 250 million cubic feet of water capable of maintaining 6,000 e.h.p. on a 25 per cent. load factor for the maximum possible periods of drought, which are calculated at one hundred days. From the proposed power-house on the shore of Loch Lomond, energy will be transmitted at 42,000 volts to the industrial areas in the valleys of the Clyde and the Leven, comprising the towns of Dumbarton, Helensburgh Renton, and Alexandria, and including shipbuilding yards, engineering and dye-works, and factories of various kinds. We do not for a moment suggest that this country can ever rival France or Switzerland in the way of water-power utilisation, but there is every reason why such natural advantages as actually exist should be fully employed for the benefit of the community, and for the extension of electrical enterprises to districts where the cost of generating energy by ordinary means would be prohibitive.

GENERAL TRADE NOTES.

Electricity Scheme in Spain.

A CONCESSION has been given to Senor Lostau of Burgos for using the waters of the Arlanza River for electric lighting and power purposes, and it may also interest our readers to learn that a syndicate has been formed for the purpose of establishing an electric tramway to connect Coruna with Santiago de Galicia and the industrial centres of Sada.

New Electric Light Plants in France.

AN electric lighting system is about to be installed at Sallans, near Fraisans (Jura), and another at Chateauville (Haute Marne).

Electrification in Victoria, Australia.

MR. BENT, the Victorian premier has lately announced his intention of appointing an electrical expert to report upon the desirability of converting the suburban railways and tramways of the city to electric traction.

Port Elizabeth Electric Lighting.

AN electric lighting scheme, the cost of which is estimated at about £100,000, is now on foot for Port Elizabeth, and we learn that the Municipality of that town is now prepared to receive offers for the installation of the new works.

Electric Railway Material Wanted.

IN the *Feuille Federale Suisse*, of the 3rd ultimo, is given the text of a decree granting a concession for the construction and operation of a new narrow gauge electric railway from Schoftland to Sursee, the estimated cost of the work being about £60,800. This enterprise involves the purchase of considerable quantities of material, and we trust a fair share of the business may find its way into this country.

Power and Lighting Scheme for Kabul.

FROM the Indian press we gather that the Ameer of Afghanistan is contemplating the installation of power and lighting plant in Kabul. The object of this western innovation appears to be to effect savings in the arms and ammunition factories belonging to the Ameer, where the cost of fuel is upwards of £26,000 per annum. British manufacturers should have an excellent chance of obtaining the contracts for the necessary electrical machinery.

Electric Lighting in Jamaica.

AN undertaking is now on foot for the introduction of electric lighting in St. Ann's Bay, a town of some magnitude in Jamaica. The proposal is to utilise the power of the river, and at the present time inquiries are being made with the object of ascertaining the probable extent of the demand. Our readers may be interested to learn that Mr. A. J. Hart, Commercial Agency Rooms, St. Ann's Bay, is acting on behalf of the promoters of the scheme.

The Winnipeg Exhibition.

THE Dominion Exhibition held last month at Winnipeg is of importance as denoting the development of Western Canada. The completion of the Canadian Pacific Railway, the consequent inrush of immigration, and the boom in Winnipeg are all part of the era of development. The exhibition was national in every sense of the word, and included representatives of British Columbia, Ontario, Quebec, and the maritime provinces. Practically every class of goods was exhibited, and in the Dominion no lack of enterprise was shown by those who had learned of the great market to be opened up in the West.

Hydro-Electric Project for India.

It is definitely stated that the Committee appointed by the Punjab Government to investigate the water problem at Simla has decided that the electrical power for pumping water from the Sutlej shall be derived from the Nauti Khud stream, and the motive-power will be transmitted electrically to the pumps to be installed at the bottom of the valley below Phagu. Further, electric mains are to be laid all over the station for public and private lighting.

Business Notice.

Messrs. C. A. Parsons and Co., of Newcastle-on-Tyne have opened an office at Howard Buildings, Johannesburg, for the convenience of their South African clients. The firm have already sold twelve turbo-generator sets in that country, and hope that the establishment of direct representation will enable them to secure a good share of the orders that are likely to be placed for electrical machinery in connection with the further development of the gold-mining industry.

Electrical Projects in Switzerland.

Among other electrical schemes sanctioned by the Swiss Federal Council are the following:—(1) An electrical railway between Martigny and Osières; (2) An electric railway from Payenne to Romont; and (3) Electric Tramways from Oberweisen to Newhausen, and from Zug to Zugerberg by way of Schoenegg. Further, the Community of Maennedorf in the canton of Zuerich, proposes the construction of an electric tramway from Wetzikon to Meilen, and electricity works are to be established by the Community of Mels in the canton of St. Gall.

Electrical Plant in Italy.

From a recent Consular report we learn that permission has now been obtained from the authorities concerned for the installation between Spezia and Portovenere, of an electric car service which will tap all the intermediate suburbs and villages. It is anticipated that both visitors and suburban residents will derive great advantage from the completion of this project, which ought to prove a very paying concern. The only means of communication at present existing between the two towns mentioned, consists of a diligence which runs four times a day, and which also carries the postal service.

Electrical Business in Canada.

Although manufacturers of general machinery are not particularly busy, the market for electrical machinery continues to be good. Inquiries are numerous, and prospects are most favourable. In this connection we may mention that the Quebec Electric Company are just commencing the installation of their plant at St. Anne and Severn Falls, and that among other enterprises contemplated by the same company, is the building and operation of an electric railway from St. Anne to Murray Bay. The Laurie Engine Co., Montreal, have recently completed the installation of two large engines for street railway power-houses at Toronto and in Winnipeg

Ilford Electric Tramways.

From the report issued relative to the working of the electric tramways at Ilford, it appears that more than five million passengers were carried during the first year of running, the receipts amounting to £23,217 17*s*. 9*d*., or about £7,000 in excess of that anticipated by the Committee, and as a balance of £4,570 remained this will probably be set aside for a suspense account. The conductors and motormen will receive an increase of ½*d*. per hour on their former pay, as well as a bonus of 10*s*. per quarter entitling them to a further increase of ¼*d*. per hour for freedom from accidents. In view of the result obtained a reduction of fares is now under consideration by the Committee.

How British Trade is Checked.

In a Consular Report issued last month, it is said: "Openings for British trade in this country (Madagascar) are very limited; shipments from the United Kingdom being, for the most part, too heavily handicapped by the application of the general tariff to admit of competition with goods of French manufacture." There are, however, a few exceptions, the following being the chief articles of British origin for which it is not policy for the Government to destroy the market:—Coal, galvanised corrugated iron and cast-iron pots and dishes. This is one of the countries where matters would be improved if we were "in a position to negotiate for reasonable trade terms."

Wireless Telegraphy in Morocco and the Azores.

We learn on the authority of Mr. F. Z. Maquire, the British representative of the De Forest Wireless Telegraph Co., that contracts have been settled for the equipment of twenty wireless stations in Morocco, as well as for stations connecting the various islands of the Azores. One great objection to ordinary telegraphs in Morocco is their liability to be cut by brigands, and the new means of communication will be much appreciated by those resident in the interior who have occasion to send messages to the coast. The objection to the establishment of telegraphic communication at the Azores has previously been found in the difficult of laying cables on the rocky bed of the sea between the islands.

The Cauvery Power-Plant, Mysore.

A report just issued by the Maharajah of Mysore states that the supply of electric power to the Kolar gold-mines, having been in operation for over twelve months, has been attended with unparalleled success. This scheme may justly be regarded as the pioneer enterprise of the kind in India, and so far as concerns the distance to which power is transmitted, it represents an advance on any similar undertaking in the world. The power contracted for by the mines is 4,000 h.p., and the net profits on the first year's operations amounted to nearly 32 per cent. A second plant is now in course of installation, and when complete the total capital expenditure will amount to £438,434. A net profit of £505,600 is assured during the first five years, and the probable

profit for the first nine years is estimated at £750,000. By the completion of the second plant a surplus of over 1,000 h.p. will be available for electric light and power, after all the demands of the mines have been complied with. It is by no means certain how long the gold-mines may remain in existence, but even if they should be worked out within the next few years, it will not be difficult to find purchasers of current, and besides the capital sunk will have been fully repaid in the form of profit. Major De Lothiniere, R.E., was the originator of the scheme, which owes much to his untiring energy and skill.

Notable Increase of British Trade in Chile.

From an official report published last month we are glad to notice that a notable increase of British exports to Chile took place in the year 1902. The figures in 1901 were 2,834,850 pesos, as compared with 4,734,297 pesos in 1902, the increase representing £142,458 in British currency. Practically the whole of this increase occurs under the head of mining machinery. In electrical goods the British exports were 55,619 pesos, and in 1902 the value rose to 152,694 pesos, the increase being £7,281. Although the figures are not large, they are, nevertheless, satisfactory. It should be stated further that increases were evident under the headings of phonographs, scientific instruments, nautical instruments, and printing machinery.

British v. German Manufacturers.

In his report for 1903, the British Consul at St. Petersburg says that British manufacturers would have little difficulty with equal treatment under the tariff, and in spite of the comparative distance and freights, in competing with their German rivals whether in quality or in price. It appears that Germany excels chiefly in the distribution of products. German commercial travellers undoubtedly make greater efforts to bring their goods before buyers, offer better terms, longer credit, and generally try their utmost to suit the convenience and even the weaknesses of the purchaser. We do not think it would always be quite safe to copy German methods in the matter of credit, but in other respects the example set is worthy of imitation.

Electro-Peat-Coal.

At the statutory meeting of the Electro-Peat-Coal Company, the chairman announced that the directors were now prepared to make preparations for the production of peat-coal. Before spending any of the shareholders' money upon plant, it was thought right to take steps for the purpose of proving that the patent was all right. Repeated searches have been made and the results submitted to Mr. Fletcher Moulton, whose opinion was that the English patent should stand, but that a further claim might be lodged following the lines of the patent recently accepted by the German patent office. The company have already sold the German patent, and we understand that the purchasers have placed an order with Messrs. Johnson and Phillips for the necessary machinery.

Sunderland Tramways.

In spite of the unfavourable weather experienced last year, the report of the Sunderland Corporation Tramways shows that fairly successful results have been attained, as will be seen by the following comparison of figures.

Year.	Receipts. £	Passengers Carried.	Car-miles Run.
1904	62,506	14,848,958	1,433,463
1903	59,142	13,987,121	1,270 957
Increase	3,364	861,837	162,506

It is also stated that the average sum taken per day amounted to £170 15s. 8d., or £3 6s. 11¾d. per car per day. The total income derived from the tramways was £63,067, and after deducting working expenses £36,318, interest, sinking-fund, and depreciation £22,329, a balance of £4,420 remained, which was available for the relief of local rates.

Buenos Ayres Grand National Tramway Company.

The total revenue of the Buenos Ayres tramways company for the year ending March last amounted to £44,513, showing an increase of £8,505 over the revenue of the previous year; but the sum of £4,395 has had to be set aside for loss on the Neuva lines. The payment of the London administration expenses and interest on the debentures left only £11,584, and after £2,150 had been transferred to debenture reserve funds and £3,726 to income bondholders' interest account, the net balance remaining was £5,708, which has been carried to a contingency fund. Interest on the income bonds will probably be paid at the rate of 5 per cent. per annum. We learn that the municipality has granted the Company a fifty-five years' concession for the electrification of their system, and that for this purpose the company has issued conversion debenture stock to the amount of £300,000. The Nueva system is to be electrified under a similar concession, with the difference that the stock issued in this case amounts to £150,000. These electrification schemes ought to result in good business for British manufacturers.

New Contracts for Collieries.

The Mitchell Main Coal Company of Wombwell, near Barnsley, Yorks, have placed an order with Messrs. Graham Morton and Co., Leeds, for the supply and erection of a set of eight bunkers; five scraper-conveyors, with delivery shoots and one elevator for conveying the coal from the ground-level to the conveyor beneath the bunkers, together with all necessary shafting and gearing, and all steel structural work in connection with the installation of the plant.

Messrs. Graham Morton and Co., have also obtained a contract from the Barnsley Main Colliery Company for a similar installation, for a smudge Elevating and Storage Plant, with waggon tippler, elevator, conveyor, and storage bunker of 500 tons capacity. The elevator is of the firm's standard cased-in type, and is 92 ft. between centres. The contract includes the complete roofing-in, and the supply and erection of all the necessary steel structural work including gantry and gangways.

An Enterprising British Firm at St. Louis Exposition.

Foremost among the few British electrical firms who are represented at the St. Louis Exposition stands the Consolidated Electrical Co. Ltd. This company has issued a prospectus for distribution at the Exposition, which gives illustrations of the different feeder panels, fuseboards, switches, circuit breakers, telephones &c., manufactured by the company. The exhibit at St. Louis includes specimens of appliances such as those supplied to the Post Office, War Office, Admiralty, and various railway companies, and consists chiefly of lightning arresters, transmitters, condensers, switches, anti-shock receivers, telephones, automatic inter-communication instruments, and other appliances for which this company is well known.

Electricity in Cape Town.

In opening the new electricity works of the Cape Town Corporation, the Mayor pointed out that the new installation had raised the capital expenditure of the Corporation's electrical undertaking to the amount of over £260,000. Mr. W. E. Long, A.M.I.E.E., the Borough Electrical Engineer, stated that while the light connections in terms of 8 c.p. lamps amounted to only 2,100 in 1895, the number had now increased to upwards of 78,850 lamps, and that whereas in 1900 power consumption was represented by only 200 h.p., the motors now connected were equal to 1,357 b.h.p. in February 1904. It is satisfactory to observe that after providing for interest and sinking-fund charges, depreciation, and extensions, a sum of no less than £3,404 has been devoted to reduction of the local rates.

"Openings for British Trade."

It may reasonably be questioned whether the practice of advertising "openings for British trade," is altogether politic. When openings really worth attention exist, our best firms generally know of them, and exhibit no lack of enterprise. In many cases, announcements of likely openings have led to the placing of orders with firms of middlemen supplying cheap foreign-made goods to the detriment of British manufacturers, though actually increasing the volume of British "trade." Again, the wide circulation of such information may assist foreigners to compete for business of which they would not hear through ordinary channels. Probably the aid of Chambers of Commerce might usefully be invoked in many cases, so as to guard against unnecessary foreign competition.

Large Contract for the Allis-Chalmers Company.

Through the agency of Thomas E. Murray, consulting engineer for the Brooklyn Rapid Transit Company, the New York Edison Company, and other companies, the Allis-Chalmers Company have received a contract for nearly 100,000 h.p. of turbo-generating equipment, with a value of over £400,000. This is the largest contract of the kind ever placed in America, the second largest having been secured by the Westinghouse Company, who will equip the new Long Island City power-house of the Pennsylvania Railroad. In the Brooklyn plant, there are to be six 5,500 kilowatt steam turbines direct-connected to 25 cycle, 750 r.p.m., three-phase alternating generators. These generators will be wound to give either 6600 or 11,000 volts. Twelve such sets will ultimately be installed in the large power house which is about to be erected by the Brooklyn Rapid Transit Company at Kent and Division Avenues, Brooklyn.

Developments in Ontario.

The charter for the St. Joseph and Stratford Electric Railway Company has been obtained, and, the survey having been completed, the engineers are now engaged upon their plans and estimates. Construction will probably be commenced within the next two or three months. A new line is to be built from Burlington to Oakville by the Hamilton Radial Electric Railway Company, the length of the new route being about 10½ miles. The Hamilton, Grimsby, and Beamsville Railway Company have arranged to extend their line to St. Catherines. Mr. W. F. Jennings, engineer to the Toronto and Hamilton Electric Railway has lately presented plans to the city council of Hamilton, showing the route along which the line will pass from Toronto to Niagara. A loop will be carried into Hamilton, and it is stated that the company propose to establish hourly services of trains. The Toronto Street Railway Company have completed the installation of storage batteries at their power-station.

Report of the Rand Central Electric Works, Ltd.

It is gratifying to note from the report of this company for the year ending December 1903, that a marked improvement has taken place since the presentation of accounts for the preceding year. Receipts in respect of the supply of power amounted last year to £70,513 9*s*. 4*d*. representing an increase of £18,043, and the profit of the year was £28,500 before making provision for depreciation. From monthly reports published by the directors of the company for the benefit of shareholders, we learn that the revenue for the first four months of last year amounted to about £8,200 more than that for a similar period in the previous year. Taking into account the sum of £17,962 13*s*. 7*d*. deducted for depreciation, a net profit of £10,584 6*s*. 7*d*. remained, which, when combined with the balance of reserve account now reduces the deficit to £11,947 16*s*. 4*d*. The general manager stated that the power generated last year was of a uniform character, and amounted to a total of 8,192,680 kw. hours. It has now been finally decided that the capacity of the plant shall be increased by 1,000 kw., and in consequence of this decision the directors have ordered a steam-turbine of 400 kw., as a preliminary step to the further extension of the plant. Among new contracts arranged by this company last year, was one for the supply of 400 kw. to the Johannesburg Municipality, and several others were concluded, amounting in all to 435 kw. A contract for supplying and erecting a power line to the mines at Geduld has also been completed.

ELECTRIC FINANCE and Legislation

Reduced Dividends.

By the ASSOCIATE EDITOR.

IT is with anything but pleasure we have to record a general reduction of dividends from Electrical Manufacturing Companies. The explanation given by those addressing the shareholders is that the reduced dividends are due to bad trade; this is no doubt true as a general statement, but we think things have been made worse by over-production. Within the last few years many very large Electrical Manufacturing Works have been erected, complete with the most modern machinery and labour-saving appliances, among others we may mention the new works of the British Westinghouse Electrical Manufacturing Co., Ltd., at Trafford Park, and the Witton Works of the General Electric Co., Ltd. These new works are able to produce an enormous quantity of electrical plant and appliances, and undoubtedly find at the present time a scarcity of orders. This is due, we think, chiefly to the tightness of money, which has put a stop to a large number of enterprises, and practically compelled the municipal authorities to check the progress of their undertakings; consequently, there is not enough constructional work in progress to keep all the new works fully employed; but by reducing prices an effort is made to secure as much work as possible, and by increased production maintain the profits. This policy must have a very serious effect upon all other electrical manufacturing companies: they must be content to do less work, or increase the competition by still further reducing prices: this will mean a serious struggle for existence; and while no doubt many companies will survive and profit by the competition, the effect upon others will be disastrous, unless special efforts are made to create a market which shall to some extent be free from competition. That this can be successfully done has been shown by the Edmundson's Electricity Corporation, Ltd., which during the seven years it has been in existence has undertaken the promotion and equipment of a large number of provincial Electricity Supply Companies. During the last year electric lighting works were completed at Caterham, Glossop, Berwick, Ryde, Surbiton, Frome and Dorking; and at Glossop and Scarborough electric tramways have been constructed and opened. The capital it has invested in these subsidiary companies amounts to £958,000; the dividend paid to the ordinary shareholders is at the rate of 7 per cent, and reserves amounting to £235,000 have been accumulated. With this successful illustration to guide them Crompton and Co. Ltd., have promoted the Electric Supply Corporation, Limited, and transferred the Chelmsford undertaking, which has been in existence for many years, and several other towns where power for supplying electricity have been obtained, and works are in progress. When one considers the immense number of small towns without any general system of electricity supply, it is easy to see the large opening for development in this direction; and consequently we anticipate that other manufacturing companies will look for similar openings. The fact that the subsidiary companies formed are dependent upon the parent companies should be of advantage: not only will the capital expended upon each undertaking be carefully considered by expert engineers thoroughly qualified to construct the undertakings upon sound yet economical lines, but the fact of having one central management controlling and directing the subsidiary companies should be of great advantage and conduce to economy.

We earnestly hope the local authorities will not make difficulties or endeavour to undertake the work themselves, because it is far more difficult to make the undertaking in a small town successful than it is in a town with a large population; in the latter higher charges can be made, and usually the consumption of energy per lamp fixed

is more. We do not anticipate any great difficulty in raising the necessary capital for the carrying out of these small undertakings, which are, if carefully managed, certain to become financially successful, and will rank with investments in gas or water undertakings.

Parliamentary Work.

THE conclusion of the Parliamentary Session of 1904 shows that, electrically speaking, the work accomplished is not all we could desire. There have been only two public Acts passed, the Electric Lighting (London) Act and the Wireless Telegraphy Act.

Sixty Provisional Orders for Electric Lighting have been passed, and thirteen Provisional Orders for Tramways, while sixty-six private Bills have been passed dealing more or less with electrical matters. We regret that the Supply of Electricity Bill and the Light Railways Bill, which were introduced by the Board of Trade with the object of improving electrical legislation, have not been passed. This is more annoying when we consider that the latter measure was practically "non-contentious," while the former had passed committees of both Houses where the objections of opponents had been carefully considered and many amendments agreed. Unfortunately, the Standing Orders do not allow a Bill to proceed from the point at which it was left in the previous Session, so that all those opponents of the measure who desire any modification will be able to oppose again when the Bill is next introduced. Both the East London and Lower Thames Electric Power Bill and the Cheshire Electric Power Bill were rejected practically because the promoters failed to produce an absolute guarantee that the capital required for carrying out the work would be forthcoming. We are pleased to see this has happened; it will check the promotion of schemes of this kind unless substantially supported, which cover a wide area, and unless carried out without delay only retard electrical progress. It would have been better had Parliament adopted this course earlier; many of the Power schemes for which parliamentary powers have been obtained are making little or no progress, and have stopped others from commencing electrical undertakings in many of the areas covered by such schemes. W are glad to see that Parliament has during the last Session taken care to consider municipal omnibus Bills; all these, whether opposed or unopposed, are now sent to the Police and Sanitary Committee of the House of Commons which goes through the clauses seriatim, with the assistance of a representative of the Local Government Board; so that we anticipate there will not be the chance of a municipality securing an important clause so easily as they have done in the past, by one might almost say accident. This should be of considerable importance, because any clause now passed after careful consideration will be almost certain to pass if presented in other Bills; whereas it was quite usual to find one Committee would pass a certain clause, while another Committee would reject: this has in the past entailed enormous expense to the promoters of such measures.

ELECTROLYSIS.

THE House of Lords have had an interesting debate upon the third reading of the Torquay Tramways Bill. Lord Clifford of Chudleigh moved the insertion of the following clause, which was agreed upon between the promotors of the Bill (the Dolter Electric Traction Co.) and the Torquay Corporation and the Torquay Gas Co., but which was struck out on two occasions by the Chairman of Committees in the House of Lords. "If at any time it be proved that any injury or damage to any mains, pipes, or apparatus of the Corporation, or the Torquay Gas Co., shall have resulted from the use of electric current on any of the tramways authorised by this Act, nothing in this Act shall relieve the Company from liability to make compensation for such injury or damage." Lord Clifford advanced as a reason for the insertion of this clause the fact that the system of tramways which it was proposed to adopt at Torquay had never before been tried in this country, and its possible effect upon gas- and water-mains was an unknown quantity, and that the Corporation and the Gas Company were justified in asking for a guarantee against damage which might be beyond that provided for by the Board of Trade regulations. Lord Balfour of Burleigh opposed the clause, which was rejected, because the Board of Trade regulations obliged the Company to be responsible for certain defined damage, and the clause would put the Corporation and the Gas Company in a specially favoured position. Some few years ago the anticipations of damage by electrolysis assumed great proportions in the eyes of the Gas and Water Companies and Municipalities owning these undertakings, and the promotors of Electric Tramways were put to enormous expense in fighting against similar clauses. Now that electric tramways have been in operation for a considerable number of years, it is satisfactory to find that the regulations of the Board of Trade effectually protect these undertakings from injury by compelling the tramways to keep the leaking return currents within specified harmless limits.

Unfortunately experience has not stopped the opposition of these Companies altogether even upon this exploded idea, but the decision of the House of Lords in the above case should tend to show how futile such opposition is upon the grounds of damage by electrolysis.

FINANCIAL NOTES.

Bridgend.

THE accounts of the Bridgend electricity department for the year ending March 31, 1904, are of interest, and show how successfully a supply of electricity may be given by the aid of a Power Company.

Capital expended	£6,153
Income	£1,145
Expenditure	£583
Gross profit	£562
Net profit	£150
Units supplied by S. W. P. Co.	77,040
„ sold for private lighting	36,182
„ „ „ public „	37,782
„ used on works	1,380
Maximum load (kilowatts)	90

Lamps connected 15 arcs, 184 incandescents

Liverpool Gas-Light Company.

SIR EDWARD LAWRENCE (chairman) in presenting the annual report, which upon a revenue of £626,108 showed a gross profit of £131,640, pointed out that last year had been an exceptionally good one, and that it was not advisable to reduce the present charges for gas. His remarks upon the present tendency for reducing the candle-power of gas are instructive, and should have the careful attention of gas consumers.

The late and present engineers to the Company had made many tests and he gave the results. The average loss of light on the reduction of candle-power from twenty to sixteen was 20.15 per cent., the reduction in price was 6.25 per cent., so that the total loss to the consumer was 13.90 per cent.

Brighton Tramways Deficit.

THE accounts of the Tramways Department of the Brighton Corporation show a deficit of £4,479 after charging interest and sinking-fund, but apparently nothing has been allowed for depreciation. Alderman Stafford, chairman of the Tramways Committee, considers the Council are responsible for the results, as they would not accept the recommendations of the Committee and made their own regulations as to fares, which allow a passenger to travel 2½ miles for a penny. The Committee now recommend a revision of the fares, which approximately reduces the distance to a mile and a half for one penny.

We hope other Corporations will note the results and the conclusions arrived at in Brighton. It is impossible for the smaller towns to successfully conduct their tramways if the fares are reduced to the low point reached by Glasgow and some other large cities; it is better to acknowledge the advantage the large cities have than to imitate with the above results.

Wireless Telegraphy.

AT the half-yearly meeting of the Eastern Telegraph Company Limited, the chairman, Sir John Wolfe Barry, while holding the view that wireless telegraphy would not compete with long-distance submarine telgraphy, pointed out that there were certain places where wireless telegraphy could be usefully employed: in the Azores, where the cables of some of the Associated Companies touch. Portugal desired telegraphic communication with some of the outlying islands, and owing to the nature of the bottom of the sea and the landing-places it was not considered suitable to make the connection by cable, and the revenue would not warrant the expenditure, but the Company intend to connect the islands by a system of wireless telegraphy worked in connection with the cable system. No doubt this view will suggest itself to other cable companies, who will derive considerable financial benefit and be enabled to extend their operations in many parts of the world without expending anything like the amount of capital which would be required if communication was maintained by the use of a submarine cable.

Leeds Tramways.

THE result of the working of the Leeds Corporation Tramways for the year ending March 25 last, have been issued in the "Standardised Form" agreed upon by the Committee of the Municipal Tramways Association and the Borough Accountants Association. We hope other Corporations will adopt this form of accounts, which necessitates the publication of details, which up to now have been very difficult to obtain, and which has made comparison between the Tramways accounts of the Corporations owning such undertakings almost impossible. The Leeds returns are excellent, and reflect great credit upon the management, and the following information will, no doubt, be of interest:

	Total.
Street miles of tramway open for traffic	42 miles 4 fur. 27.3 yds.
Track miles in operation (double, 39 miles 80.8 yds.; single, 3 miles 3 fur. 166.5 yds.)	81 miles 4 fur. 108.1 yds.
Traffic revenue	£277,665 12s. 1d.
Total revenue	£280,362 16s. 3d.
Working expenses	£148,894 18s. 1d.
Percentage of working expenses to gross receipts	53.07
Fixed charges	£54,732 17s. 5d.
Car miles (revenue miles, 6,091,437; dead miles, 124,362)	6,215,709
Total units generated	9,518,680
Units per car mile, including transmission losses	1.37
Cost of generating per unit	.35d.
Passengers carried	60,739,234
Average fare per passenger	1.097d.
Average number of passengers per car mile	10.13
Average number of running cars	180
Average traffic revenue per car mile	10.94d.
Average total revenue per car mile	11.05d.
Average working expenses per car mile (including depreciation)	6.85d.
Average working expenses per car mile (excluding depreciation)	6.09d.
Number of cars in stock	245
Total borrowing powers	£1,146,000 0s. 0d.
Total capital expenditure	£1,140,511 12s. 6d.
Total amount set aside for sinking fund to March 25, 1904	£109,706 5s. 10d.
Total amount of depreciation and reserve fund	£82,906 1s. 8d.
Total amount transferred to City Fund in relief of rates to date	£206,580 17s. 9d.
Undertaking purchased from the Leeds Tramway Company, February 2, 1894, amount paid	£114,590 6s. 8d.
Length of tramways (single track) at date of purchase	22 miles 780 yds.

New ELECTRICAL PATENTS

Selected Specifications.

By E. de PASS, F.Ch. Inst. P.A.,
78 Fleet Street, E.C.

Electric Block Signalling Systems.

No. 707. Dated Jan. 11, 1904. Louis Charles Werner, of Hartford, U.S.A.

This invention relates to a novel semaphore, and operating mechanism for moving the signal arm to the several positions indicative of the signals which serve for the guidance of the engineers.

The object of the invention is to provide operating mechanism of novel character, arranged for electrical control and capable of providing for the automatic display of four signals determined by the positions of the arm.

A further object of the invention is to automatically lock the arm in any position to which it is moved, and to equip the semaphore with operating motors, so related to the locking mechanism and a suitable controlling device that the locking mechanism will be released immediately prior to the movement of the motor or motors, and locked as soon as the motor mechanism has moved the signal to the desired position.

Claims.—(1) In a block signal system for railways, the combination with a signal device, and a motor for moving the same to its different positions, of a pair of signal locking devices, a motor circuit controlling the operation of the motor in one direction and including an electro-magnet disposed to operate one of the locking devices, a shunt terminal for said motor circuit, said shunt terminal including an electro-magnet controlling the operation of the other locking device, reversed generators in the motor circuit and in the shunt terminal thereof, respectively, and a relay disposed to close the circuit through either generator and magnet, whereby the motor may be operated in either direction, and the signal device locked in either of its set positions.

(2) In a block signal system for railways, the combination with a signal device, a pair of motors, the differential connections for moving the signal device different distances in the same direction, of locking mechanism for locking the signal in its set positions, separate circuits controlling the operation of the motors and their associated locking mechanism, and a make-and-break device in each of said circuits.

(3) In a block signal system for railways, the combination with a signal device and a pair of operating motors, of a pair of locking devices associated with each motor to lock the signal in its set positions, an independent motor circuit for each motor, said circuit including a generator and an electro-magnet controlling the operation of one of the locking devices of the adjacent motor, and each of said motor circuits having a shunt terminal including a reversed generator and an electro-magnet controlling the operation of the other locking device of the adjacent motor, and a relay having its armature interposed between the direct and shunt terminal of each motor circuit, whereby the circuit may be closed through either generator and magnet to operate the motor in either direction, and to lock the signal in either of its set positions.

"Transmission of Electrical Impulses."

(No. 8612. Dated April 14, 1904. John Stanley Richmond, of New York, U.S.A.)

This invention relates to the art of transmitting electrical impulses through electrical transmission mediums, and more especially such impulses as are utilised in the arts of telegraphy and telephony, although not restricted to these arts, the objects of the invention being to enable such impulses to be transmitted through long cables, submarine, or otherwise or other transmission mediums, and to render their transmission through short cables or other

transmission mediums possible or more expeditious and efficacious.

Claims.—(1) The herein described improvement in the art of electrical transmission which consists in producing in adjacent conductors electrical impulses simultaneously equal at contiguous points but differing in this that the voltage of the one is above and that of the other equally below the maintained zero voltage; substantially as and for the purpose set forth.

(2) The described improvement in the art of electrical transmission which consists in the transmission through contiguous conductors capable, under similar electrical conditions, of similar capacity effects, of electrical impulses simultaneously equal at contiguous points and simultaneously varied in equal ratio as regards the two conductors, but differing in this:—that, simultaneously and at contiguous points, the voltage established in one of the conductors is above while that in the other is equally below the voltage of the medium surrounding the conductors.

(3) The hereinbefore described improvement in the art of electrical transmission which consists in maintaining zero voltage at the meeting-point of adjacent conductors and simultaneously producing in said conductors electrical impulses simultaneously equal at contiguous points but differing in this that the voltage in the one conductor is above and that in the other equally below the maintained zero voltage.

(4) The described improvement in the art of electrical transmission which consists in the transmission through contiguous conductors forming parts of a single circuit, of impulses inaugurated by transmitting instrumentalities common to the two transmission mediums, said impulses differing in this:—that, simultaneously and at contiguous points, the voltage established in one of the conductors is above while that in the other is equally below maintained zero voltage.

(5) In a system of electrical transmission two conductors forming the sides of a metallic circuit, combined with means for maintaining zero voltage at the meeting points of the two conductors.

(6) In a system of electrical transmission, two equal conductors forming the sides of a metallic circuit, combined with a ground connection for maintaining zero voltage at the meeting-point of the two conductors.

(7) In a system of electrical transmission, two equal conductors, forming the sides of a metallic circuit, combined with means for maintaining zero voltage at the meeting-points of the two conductors, and means for creating impulses in the said conductors simultaneously equal at contiguous points but differing in this, that the impulses in one conductor are equally above as those in the other are below the maintained zero voltage.

(8) In a system of electrical transmission, equal contiguous insulated conductors equally insulated from and surrounded by a sheath repeatedly grounded, said conductors forming sides of a metallic circuit, the meeting-points of said conductors grounded whereby zero voltage is maintained at that point and equal impulse creating means located on opposite sides of the zero points, said impulse creating means simultaneously creating impulses in one conductor above and in the other conductor impulses equally below the zero voltage.

(9) In a system of electrical transmission, equal contiguous conductors insulated from each other and connected together to form a metallic circuit, a ground connection at the meeting-points of the conductors and equal generators included in said conductors equidistant electrically from the zero point said generators being in series with each other in the circuit.

(10) In a system of electrical transmission equal contiguous conductors forming the sides of a metallic circuit and an earth connection where said equal conductors meet, whereby zero voltage is maintained at that point, combined with means for creating impulses simultaneously equal at contiguous points in the two conductors, respectively, but differing in this, that the impulses in one conductor are equally above as those in the other are below zero voltage.

(11) In a system of electrical transmission, equal insulated conductors forming sides of a metallic circuit, a ground surrounding said conductors, a ground connection at the meeting-point of said conductors whereby earth voltage is maintained at that point, and means for creating impulses simultaneously equal at contiguous points in the said conductors one of said points being in one conductor and the other point in the other conductor, but differing in this that the impulses in one conductor are in voltage as equally above as those in the other conductor are below said voltage.

(12) In a system of electrical transmission, equal contiguous insulated conductors equally insulated from and in similar proximity to a medium repeatedly grounded, said conductors forming sides of a metallic circuit and having their meeting-point grounded whereby zero voltage is established at that point, electrical impulse generating apparatus so located in series in such circuit and so that the electrical medial point in such apparatus is electrically equidistant from zero point of said circuit and other apparatus in series in such circuit so located that the electrical medial point in such other apparatus is electrically

equidistant from zero point of said circuit for utilising the impulses generated.

"Improvements in and relating to Brakes, particularly applicable to Brakes for Electric Tramcars."

(No. 5204. Dated March 5, 1903. Thomas Vickers and Ernest Andrews, both of Nottingham.)

This invention relates to improvements in electric brakes of the kind used on electric tramcars, the said improvements being particularly applicable to tramcars fitted with safety appliances at the ends of the same; the object of the invention being the provision of means whereby the magnetic brake is applied automatically whenever the safety gate or guard, or both, is or are moved from its or their normal position.

According to the invention, as applied to a tramcar fitted with the usual controller and hand operated magnetic brake, the electric connections between the controller and motor are fitted with a switch so arranged that when the switch lever is in one position the current from the trolley wire passes to the motor, and when the switch lever is in another position, the current from the motor, when acting as a generator, passes to the magnetic brake.

The switch lever is connected by levers and links, gearing or equivalent mechanism to the gate, or guard of the safety appliance, and when this appliance is operated by any obstruction on the road, the magnetic brake is automatically applied. In one arrangement the switch is held in its motor driving position by a catch, from which it is liberated by an arm on the gate axle, and when so liberated is moved to the brake position by a spring. The switch may be positively operated in either or both directions from the gate or guard, or both the gate and guard may be coupled to the switch.

Claim.—The combination with a controller, motor, and magnetic brake, as used on electric tramcars, of an automatic switch arranged and operating for the purpose set forth.

"Improvements in Electric Railways."

(No. 789. Dated January 12, 1904. Leon Wilbur Pullen, of Camden, New Jersey, U.S.A.)

The object of the invention is to provide means adapted to existing railways for operating an electrically propelled car and whereby the circuit for supplying current to the car is only completed at points adjacent to the car as it travels over the working or supply conductors or contact blocks. In this manner, the supply conductor may be enclosed or protected beneath the road bed and contact blocks upon the surface put into electric circuit with the said supply conductor only when and during the time the car is passing them, and the supply of current to the motor on the car received from said contact blocks when in closed circuit.

In carrying out the invention, the road bed is provided with a series of specially constructed electro-magnetic switches adapted to be energised by magnets or pole pieces upon the car whereby they will close automatically for a period corresponding to the time the car is over them. These switches control a series of branch circuits receiving current from a supply circuit and supply it to contact blocks upon the surface of the track. The car is furnished with one or more electric motors to propel it and magnets for operating the electromagnetic switches, whereby said switches may be automatically energised and caused to close and open the circuits in succession as the car passes them and make electric contact with the contact blocks arranged along the railway. The car is further provided with a long travelling contact shoe or collector adapted to make contact with the contact blocks along the track and has capacity for adjustment relative thereto, the length of said shoe being somewhat greater than the distance between two successive contact blocks so as to at all times make electric circuit with one block before breaking contact with another.

Claims.—(1) An electric railway having a line conductor connected at intervals by branch conductors and combined with magnetic switches distributed along the railway said switches each having a loose gravity actuated magnetic armature arranged transversely to the length of the track and also two caps provided with contacts to constitute a two-pole switch and adapted to be operated by means of a magnet having north and south poles arranged on the car said poles being parallel to each other and extending in length in the direction of the length of the car and located respectively above the two caps of the magnetic switches.

(2) The magnet on the car for operating the switch provided with magnetic coils arranged between the poles of the magnet when combined with an energising circuit including the said coils and energising means independent of the current flowing through the line conductor and under the control of the operator of the car for energising the magnet when the magnetic switches are open and it is desired to put them into action to start the car.

(3) An electric railway provided with a series of magnetic switches arranged at intervals in its length for supplying current

to the motors on the cars and consisting of an enclosed case, combined with two caps in the upper part of the case having contacts insulated therefrom, a contact block arranged above and insulated from the case and electrically connected to one of the contacts an electric circuit supplying current to the other contact a transverse magnetic armature arranged below the two contacts adapted to be raised under magnetic attraction exerted through the contacts and caps, and insulating supports for the armature to hold it close to the contacts with freedom of upward movement.

(4) The construction of magnetic switch specified in Claim 3 having the contact caps and contacts either or both made of magnetic material to reduce the magnetic resistance to the armature.

(5) The construction of magnetic switch specified in Claim 3 having the armature made tubular whereby it has large circumference and light weight.

"Improvements in Electric Me ing Furnaces."

(No. 5921. Date of application March 10, 1904. Date claimed under International Convention, March 21, 1903. La Société Anonyme l'Industrie Verrière et ses dérivés, Brussels.)

This invention relates to electric melting furnaces for use in chemical and metallurgical industries, and which are charged with ore or with salts mixed, after having been disaggregated, with materials containing carbon, metal scraps and metallurgic slag, being subsequently added.

According to the invention a charge of this nature is included in an electric circuit, as a heat resistance, by means of current conductors or leads embedded, at different heights, in the wall of the furnace in order to thus effect the heating, the reaction and the melting of the resulting products. In order to allow of interposing a layer of charge of varying thickness the wall of the furnace is provided with a number of the above-mentioned fixed current conductors or leads arranged one above another so that these different leads can be included in the circuit exactly according to requirements. As, in this furnace, movable electrodes are not made use of, the operations can be effected with exclusion of air and the gases can be drawn in, almost in their natural condition (without mixture with air) which is particularly advantageous from a hygienic and economic point of view. Moreover, in this furnace the consumption of electrodes is reduced to a minimum seeing that the electrodes cannot burn and are not exposed to mechanical wear which can besides be prevented by suitably constructing the walls of the furnace.

Claim.—In electric furnaces for chemical and metallurgical operations in which the charge serves a heat resistance, arranging a number of current conductors or leads at different heights in the wall of the furnace substantially as hereinbefore described.

Des Elektroingenieur's Taschenbuch fur Bau und Betrieb Elektrischer Bahnen.

("Electric Traction Pocket-Book.") Authorised German Edition of Philip Dawson's Pocket-Book. By J. Zacharias. W. Knapp, Halle a. S. M. 15.

The German edition of Mr. Philip Dawson's well-known "Pocket-Book" is far from being a mere literal translation, the editor having taken special pains to adapt it to the requirements of German traction engineers. The section on steam boilers, steam- and gas-engines has been entirely omitted. Thanks to the co-operation of a number of German firms, much valuable information regarding German practice has been secured, and this should prove interesting reading to English engineers. The most meagre section of the book is that dealing with high-speed electric traction, which occupies only a little over a page, it seems a matter for regret that more information should not have been given on this subject, especially in view of the fact that Germany has been the pioneer of high-speed traction. A word of praise is due to the publishers for the general excellence of the "get up" of the book, the type being very clear and the majority of the illustrations well executed.

Die Elektrochemische Reduktion der Nitroderivate Organischer Verbindungen.

("The Electro-chemical Reduction of the Nitro-derivatives of Organic Compounds.") By J. Möller. W. Knapp, M. 4.

The technical importance of electro-chemical methods in organic chemistry is sufficiently well illustrated by the fact that a whole series of compounds (chloral, iodoform, &c.) are, at present, being produced by electro-chemical means, and the electro-chemical reduction of the nitro-derivatives must be regarded as an important branch of organic electro-chemistry. In the monograph before us, the author gives a very complete account of the theoretical and experimental aspects of the subject, the results obtained in acid and alkaline solutions being separately dealt with throughout. The application of the electric current to the solution of the problems of organic chemistry has frequently opened up new fields of research, and the present monograph should prove interesting not only to those actually engaged in technical organic electro-chemistry, but to all chemists who take an interest in the important developments which have been taking place in this subject during the last seven years.

Die Elektrochemische Industrie Deutschlands.

("German Electro-chemical Industry.") By Dr. P. Ferchland. W. Knapp, Halle. M. 2.50.

This monograph aims at presenting a general survey of the present state of the electro-chemical industry in Germany. The author's account is characterised by extreme caution and deep critical insight, and by the more enthusiastic and hopeful workers in the field of electro-chemistry he will, no doubt, be regarded as a pessimist. Nevertheless, his sane and careful analysis of the available data is bound to carry conviction with it. He hopes for most from the electric furnace, and for nothing at all from the domain of organic electro-chemistry. Not the least interesting part of the book is the highly suggestive introduction, in which the author briefly traces the rise of the electro-chemical industry in Germany, and analyses the conditions which have enabled the United States to become the pioneer state of the modern electro-chemical industry.

Berechnung und Entwurf Elektrischer Maschinen, Apparate und Anlagen.

("Calculation and Design of Electrical Machines, Apparatus and Power-Plants.") By Dr. F. Niethammer. Volume i., Part 2. F. Enke, Stuttgart. 1904.

We heartily welcome the appearance of the second part of vol. i. of Dr. Niethammer's great treatise, to be completed in five volumes. All that great learning and wide practical experience can do to make a text-book useful and interesting to an engineer, we find fully realised in the present volume. It is an exceptionally thorough exposition of a subject which we do not remember having seen treated with equal fulness elsewhere.

The book opens with a general review of the various materials used in dynamo construction. Then follows a detailed discussion of shafts, bearings, methods of lubrication, armature cores and spiders, mechanical details of armature windings, commutators and their construction, brush-holders and brush-gear, field frames and their design, field coils, terminals, methods of driving and couplings, belts and pulleys, rope driving, toothed gearing, belt tightening gear, bed-plates and foundations, weight and cost of dynamos. It is impossible in a brief review, to give the reader any idea of the care with which each little detail

is treated, and of the mass of valuable information to be found on almost every page of the book. Not the least striking feature of it is the wealth of scale-drawings, there being 472 illustrations, all of exceptional merit.

Carborundum.

By Francis A. J. Fitz-Gerald. Translated into German by Dr. Max Huth, W. Knapp, Halle a. S. M. 2.

This German version of Mr. Fitz-Gerald's monograph on carborundum is one of the admirable series at present in course of publication by the enterprising firm of Messrs. Knapp, of Halle. The book is divided into five sections, which treat respectively of the history of carborundum, the carborundum furnaces of Acheson, the purification, properties, and analysis of carborundum, its practical applications, and the simultaneous production of zinc and carborundum. The importance of the carborundum industry does not appear to be fully realised in Europe, where there is a tendency to regard this product as more or less of a scientific curiosity. A single glance at the illustration on page 37 of our monograph will, however, do much towards dispelling the notion; we may mention that even in 1902 the production of carborundum amounted to close on 1,700 tons. A very useful bibliography of the subject is given in an appendix.

Das Elektrische Bogenlicht. Erste Lieferung.

("The Electric Arc Light." Part 1.) By W. B. von Czudnochowski, Leipzig: S. Hirzel. 1904.

This is the first part of a comprehensive monograph on the subject of the electric arc and arc lighting. The author does not, however, confine his attention entirely to arc lighting and deals with a large number of allied subjects in this introductory part. After a historical sketch, the subject of photometry is discussed, and the distribution of the luminous intensity in arc lamps of various types is considered. This is followed by a general account of projectors for lighthouse purposes, and a detailed discussion of the laws of radiation. The appendix contains a useful bibliography. The work is written in a clear and interesting style.

Die Beziehungen Zwischen Aequivalentvolumen und Atomgewicht.

("Relations Connecting Equivalent Volume with Atomic Weight.") By Dr. W. Borchers. W. Knapp, Halle, M. 0.80.

The applications which have been hitherto made of Mendelejeff's law to the graphical representation connecting various properties of the elements with their atomic weights, suffer from certain irregularities and uncertainties. In studying the relations connecting the electro-chemical equivalents of the elements, the author of the pamphlet under review hit upon the idea of plotting the "equivalent-volume" against the atomic weight. By the "equivalent volume" is meant the volume, in c.c., occupied in the solid state by a mass of the element which, in the ionic state, carries a charge of 96,540 coulombs. The curves so obtained are found to exhibit remarkable regularity, and the author utilises them for the purpose of indicating the existence and outlining the characteristic properties of certain missing elements.

Modern Electric Practice.

Editor: Prof. Magnus McLean, M.A., D.Sc. Vol. iv. London: The Gresham Publishing Co. Price 9s.

The fourth volume of this work is now to hand and it contains the remaining matter of Section III. dealing with Electric Tramways. The first two chapters of this section are included in the third volume. Seven chapters make up the present volume and they describe overhead construction, tramway feeders, surface contact systems, conduit systems, rolling-stock and equipments, electric boats and motor-cars, and electric traction on railways. The chapter on overhead construction is very complete, every aspect of the question being considered. The chapter on tramway feeders may also be regarded as comprehensive as well as concise, the arrangement of economical loss in feeders and methods of transmission, and laying being well set out. The chapter on surface contact systems goes into great detail of the many proposals for this method of traction. As an historical account this is interesting but for practical purposes of little value except so far as the few successful systems are concerned. The conduit system which is perhaps in more favour than the surface contact, is also carefully treated, and the cost portions are very instructive. Under rolling-stock and equipments there are full particulars of cars, car bodies, trucks, brakes, and methods of control, but we think the regenerative system of car control should have found a place seeing that its efficiency as compared with the series parallel has been conclusively proved. The chapter on motor-cabs and boats is very complete. The volume concludes with a chapter on electric traction on railways which deals concisely with the subject, reviewing the possibilities of the various methods suggested. No particular details are given of these, but their technical merits are chiefly emphasised and compared. The volume is a valuable addition to the series, the remaining two of which we shall look forward to with interest.

The leading contents of the periodical electrical press of the world, papers read before Learned Societies, and any other literature treating upon electrical subjects are arranged *under subject-matter* in this section. Suitable references are made to the names and dates of the various papers, and the whole forms an index guide of considerable importance and value.

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New Power Plant, Twin City Rapid Transit Co.	*Strt. Rly. Rev. Aug./04.*
*Variable Speed Motors. (V.) W. Baxter (jun.).	*Machy. N.Y. Aug./04.*
*Electrically Driven Portable Tools. A. Gradenwitz.	*Machy. N.Y. Aug./04.*
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Single-Phase Series Motor. R. Mehull.	*Elec. Wrld. & Engr. 6/8/04.*
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Electric Cranes. (III.) F. L. Berry.	*Mech. Wrld. 12/8/04.*
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Joint Use of Poles by Public Service Companies. D. L. Gaskill.	*Ohio Elec. Assoc. 17/8/04.*
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*Electricity from Water-Power. A. A. Campbell-Swinton.	*Brit. Assoc. 23/8/04.*
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Central Station Practice.

Articles.

*Practical Hints on Power Switchboards. W. Kavanagh.	*Power, Aug./04.*
Care of Dynamos and Motors. L. E. Gorizalez.	*Power, Aug./04.*
Engine-Room Experiences. L. S. Brainerd.	*Power, Aug. /04.*
*The Principles and Practice of Superheating. W. H. Booth.	*Try. & Rly. Wrld.* 11/8/04.
Some Notes on Condensing Plant. E. K. Scott.	*Try. & Rly. Wrld.* 11/8/04.

Papers.

A Day Load as a Factor in Central Station Earning Capacity. L. D. Hoit.	*Ohio Elec. Lt. Assoc.* 16/8/04.
Transformed Testing for Central Stations. S. E. Johaneson.	*Ohio Elec. Lt. Assoc.* 16/8/04.
Relation of the Supply House to the Central Station. P. R. Boole.	*Ohio Elec. Lt. Assoc.* 16/8/04.
Unaccounted-for Current. W. E. Richardards.	*Ohio Elec. Lt. Assoc.* 17/8/04.
The Steam Turbine and its Use. E. C. Crocker.	*Ohio Elec. Lt. Assoc* 17/8/04.
The Instrument Equipment of a Testing Department. F. Conrad.	*Ohio Elec. Lt. Assoc.* 17/8/04.
*Voltage Regulation—Does it Pay? Why? L. G. White.	*Ohio Elec. Lt. Assoc.* 17/8/04.
Effects of Receiver-Drop in a Compound Engine. J. W. Hayward.	*Brit. Assoc.* 19/8/04.
Some Notes on European Testing Laboratories. Dr. C. H. Sharp.	*Assoc. Edison Ill. Co.* 30/8/04.
Measuring Instruments in Generating and Sub-Stations. C. D. Haskins.	*Assoc. Edison Ill. Co.* 30/8/04.
Troubles and Losses between Generators and Consumers' Premises. P. Junkersfeld.	*Assoc. Edison Ill. Co.* 30/8/04.
Notes on Economy in Steam Production. W. F. Wells.	*Assoc. Edison Ill. Co.* 30/8/04.

Finance and Legislation.

Articles.

Local Authorities and Electrical Developments in England. W. V. Ball.	*Elec. Wrld. & Engr.* 6/8/04.
Some Qualifications of the Railway Accountant. W. B. Brockway.	*Strt. Rly. Jrnl.* 6/8/04.

Papers.

Graded Costs of Electric Supply. M. E. Turner. *Ohio Elec. Lt.Assoc.* 17/8/04.

*To What Extent Should Central Stations Make Investments? J. F. Gilchrist. *Assoc. Edison Ill.* 30/8/04.

Trade and Commerce.

Articles.

Electricity and Our Rights. E. Palitschek. *Schweir. Elek. Zet.* 20/8/04.

Papers.

Some Commercial Problems. J. D. Trael. *Assoc. Edison Ill. Co.* 30/8/04.

Patents.

Papers.

*Address Section G., British Association. C. A. Parsons. *Brit. Assoc.* 18/8/04.

Articles marked with an asterisk are of exceptional interest, and well worth reading. Copies of any article or paper can be obtained on application to this office, a nominal fee only being charged for the clerical time occupied in taking out same. If desired, the whole publication will be procured (same not being out of print) on payment of the published price.

Where foreign papers have a similar title to those published in this country, the initial letters of the place of publication will be inserted after the abbreviated name of the particular paper; for instance, the English Electrical Review will be abbreviated Elec. Rev., and the American Electrical Review, Elec. Rev. N.Y.

New Catalogues.

Power.

Disposal of Trade Waste.

MELDRUM BROTHERS, LTD., Timperley, Manchester, have sent us a copy of a paper read by Mr. W. F. Goodrich before the Royal Institute of Public Health, in which some valuable details are given of the methods of burning the waste material of large institutions, such as asylums, hospitals, &c. The destructors employed were all of Messrs. Meldrum's manufacture.

Waste Heat from Coke Ovens.

THE STIRLING COMPANY, 53 Deansgate Arcade, Manchester, has issued a pamphlet (No. 13) dealing with the Utilisation of Waste Heat from Coke Ovens. We make detailed reference to the tests recorded in this booklet in our Power Section this month, so that we will content ourselves with recommending our readers interested in steam-raising by this means to procure a copy.

Steam Raising.

THE STIRLING COMPANY, 53 Deansgate Arcade, Manchester. In addition to the booklet referred to above, we have also received three further brochures dealing with tests of their steam-boilers. One of these (No. 14) draws comparisons between the company's boilers and those of the Babcock Wilcox Company at the G. E. Co.'s Plant, Schenectady. All three booklets make very good reading, and should be on the desk of every power-station engineer.

Dynamos and Motors.

THE ELECTRIC CONSTRUCTION COMPANY, Bushbury Engineering Works, Wolverhampton. A handsome and a comprehensive display-card is just to hand from this company, who must be complimented on its design and arrangement. The firm's chief specialities in dynamo and motor work, with innumerable applications of the latter, are dotted over the face of the card, and tend to make a pleasing combination, yet instructive withal. We should think there will be a big call for these attractive osters.

Suction Gas Power.

FIELDING AND PLATT, LTD., Atlas Works, Gloucester, have forwarded a booklet on the above subject, which contains material of extreme interest to electrical engineers. We refer briefly to the subject in the Manufacturers' Section this month, but those requiring a cheap method of producing electrical energy in isolated districts should obtain a copy of this valuable booklet. The high-speed gas-engine of this firm is described in detail in the Manufacturers' Section of this issue, but a closely detailed account, reprinted from *The Engineer*, will, we are sure, be forwarded on application.

Cranes and Motors.

THE BRITISH THOMSON HOUSTON COMPANY, LTD., Rugby. From this company we have received pamphlets Nos. 169-170, dealing respectively with single-phase induction motors and electrically operated cranes. The former are classified in standard and semi-standard sizes to 20 h.p., 100-200 volts, 50-60 cycles. Particulars are also included of starters for these motors. The crane list is particularly complete, containing as it does details of the electrical equipments made by the company for cranes of every class. The motors and controllers only are of course supplied, the crane being the work of some recognised contractor. The list is well illustrated and contains diagrams of the motor and controller connections.

Liquid Fuel.

LUCAL LIGHT AND HEATING COMPANY, LTD., 65 West Regent Street, Glasgow. All engineers concerned with the cheap production of electric power are interested in liquid fuel, and though, as we have pointed out, in previous issues, the use of this method for steam-raising iu supply stations is limited, there are still hopes of its ultimately becoming more general. The company mentioned above has issued a copy of a report by Prof. W. H. Watkinson on tests conducted early in the present year on their system of oil-firing as applied to a marine boiler. This report makes instructive reading, and should be procured by all users of coal in power stations. Space will not permit us to give details of the tests, but they are sufficiently meritorious to command wider attention.

Lighting and Heating.

Meridian Lamp.

THE BRITISH THOMSON HOUSTON COMPANY, LTD., Rugby. In our Lighting and Heating Section this month we give some illustrated particulars of this lamp, which is described in pamphlet No. 171.

Fuses and Cut-Outs.

THE BRITISH THOMSON HOUSTON COMPANY, LTD., Rugby. List No. 84 contains prices and particulars of fuses and fusible cut-outs. The types described and priced are open fuse blocks, switch fuses, cut-outs with magnetic blow-out, expulsion fusible cut-outs, enclosed fusible cut-outs, primary cut-outs, and tube expulsion fusible cut-outs.

Switch and Fuse Boards.

THE GENERAL ELECTRIC COMPANY, LTD., Queen Victoria Street, E.C. The "S" section of the company's catalogue contains details and prices of switch- and fuse-boards, branch switches, cut-outs, lampholders, &c., electric light supplies, and Robertson and Nernst lamps. The particulars of the latter are very complete, while some very full particulars are given of Robertson lamps.

Accessories.

THE SIMPLEX STEEL CONDUIT CO., LTD., 20 BUCKLERSBURY, E.C. An elaborate wall hanger displaying every conceivable portion of the conduits and accessories made by this company has reached us. The hanger is mounted in two lengths of "Simplex" with bushed ends and the whole is very effectively produced. The card should be hung in every wiring contractors office for reference.

Telegraphy and Telephony.

Telephones.

THE GENERAL ELECTRIC COMPANY, LTD. (as above). The "K" section of the general catalogue deals with telephones, telephone switchboards, fire-alarms, and accessories. The list is very complete, and will be found to contain every desired particular of telephones and accessories. The "Handcom" intercommunication series are very valuable, as are several other systems described.

Central Station Practice.

Instruments.

FERRANTI, LTD., HOLLINWOOD, LANCS. List No. 12 describes the indicating wattmeters of this form. These instruments are operated on the induction principle similar to that employed with the Ferranti A.C. Meter. They have a wide open scale and are placed in a cast-iron case so that the movement is unaffected by external magnetic fields. In our Manufacturers' Section this month, we give an illustration of one of the instruments.

Forthcoming Events

Exhibitions.

Universal Exposition, St. Louis, U.S.A.
Now open. Remains open till *December* 1, 1904.

Exposition Internationale au Grand Palais, Paris.
August to November 1904.

Industrial Exhibition, Cape Town.
November 1904 *to January* 1905.

Meetings, Conventions, etc.

American Street Railway Association.

23rd Annual Convention. St. Louis Exposition. *October* 12 *and* 13, 1904.

International Electrical Congress, St. Louis Exposition.
September 12-17, 1904.

Conventions will be held by the following Societies: the American Institute of Electrical Engineers, the American Physical Society, the American Electro-Chemical Society, the American Electrotherapeutic Association, the International Association of Municipal Electricians, the British Institution of Electrical Engineers. Delegates from the Société Internationale des Electriciens, the National Electric Light Association, and the Association of Edison Illuminating Companies.

The papers for section A have already been published in previous issues. We give particulars of papers in other sections herewith.

THE INTERNATIONAL ELECTRICAL CONGRESS.

PARTICULARS of the papers to be read in the most important sections are given herewith: Section D.—Electric Power Transmission (Chairman, Mr. Charles F. Scott; secretary, Dr. Louis Bell). E. Bignami, "Electrical Transmission Plants in Switzerland"; H. M. Hobart, "Condition Conducive to Economy in Motor Design"; Mons. Maurice Leblanc, "Transmission of Alternating Currents over Lines Possessing Capacity"; Prof. G. Mengarini, "Utilisation of Hydraulic Powers in Italy"; F. G. Baum, "High-Potential, Long-Distance Transmission and Control"; F. O. Blackwell, "The Tower System of Line Construction"; H. W. Buck, "The Use of Aluminium as an Electrical Conductor"; V. G. Converse, "High-Tension Insulators"; M. H. Gerry, Jr., "Line Construction and Insulation for High Tensions"; L. M. Hancock, "Bay Counties Transmission System"; R. L. Hayward, "Some Practical Experiences in the Operation of Many Power Houses in Parallel"; J. F. Kelly and A. C. Bunker, "Long-Distance Power Transmission"; P. M. Lincoln, "Transmission and Distribution Problems Peculiar to the Single-Phase Railway System"; R. D. Mershon, "The Maximum Distance to which Power Can be Economically Transmitted"; P. N. Nunn, "Pioneer Work of the Telluride Power Co."; J. S. Peck, "The High-Tension Transformer in Long-Distance Power Transmission"; Dr. F. A. C. Perrine, "American Practice in High Tension"; Dr. C. P. Steinmetz, "Theory of Single-Phase Motors." Section E.—Electric Light and Distribution (Chairman, J. W. Lieb, Jr.; secretary, Gano S. Dunn): Prof. André Blondel, "Impregnated Arc Light Carbons"; Herr Max Déri, "Single-Phase Motors"; Herr E. de Fodor, "Rates for Electricity Supply"; Sig. Ing. E. Jona, "Insulating Materials in High-Tension Cables"; Prof. W. Kübler, "Upon Means for Compensating the Series Connection of Induction Motors"; Herr Karl Roderbourg, "Storage Batteries"; Sig. Ing. Guido Semenza, "Commercial Limits of Electric Transmission with Special Reference to Lighting Service"; Dr. G. Stern, "The Superiority of the Alternating Current for Distribution in Large Cities"; Dr. W. Wedding, "Measurements of the Energy of Light and Heat Radiation from Electric Light Sources"; Arthur Wright, "Recent Improvements in Electrolytic Meters"; Prof. S. P. Thompson (subject to be announced later); B. A. Behrend, "The Testing of Alternating-Current Generators"; George Eastman (representing Nat. Elec. Light Assoc.), "Protection and Control of Large Light-Tension Distribution Systems"; W. C. L. Eglin (representing Assoc. Edison Illum. Cos.); "Rotary Converters and Motor Generators in Connection with the Transformation of High-Tension Alternating to Low-Tension Street Current"; W. L. R. Emmet, "The Effect of Steam Turbines on Central Station Practice"; Louis A. Ferguson (representing Assoc. Edison Illum. Cos.), "Underground Electrical Construction"; Gerhard Goettling (representing Assoc. Edison Illum. Cos.), "Storage Batteries as an Adjunct to Central Station Equipment"; G. Ross Green (representing Nat. Elec. Lt. Assoc.), "American Meter Practice"; Caryl D. Haskins, "Metering Efficiency on Customers' Premises"; Francis Hodgkinson, "Steam Turbines"; John W. Howell, "Incandescent Lamps"; Philip Torchio, "Distributing Systems from the Standpoint of Theory and Practice"; W. F. White, "The Selection of a Distributing System for a Large City." Section F.—Electric Transportation (Chairman, Dr. Louis Duncan; secretary, Mr. A. H. Armstrong): Ernst Danielson, "Theory of Compensated Repulsion Motor"; Philip Dawson, Esq., "Electrification of British Railways"; Herr F. J. Eichberg, "Single-Phase Electric Railways"; Prof. Dr. F. Niethammer, "Alternating *v.* Direct-Current Traction"; Prof. Dr. Rasch, "The Puffer Machine in Railway Service and Its Most Suitable Control"; A. H. Armstrong, "The Electrification of Steam Lines"; B. J. Arnold, "Electric Railways"; Louis Duncan, "General Review of Railway Work"; J. B. Entz, "The Storage Battery in Electric Railway Service"; C. O. Mailloux (to be announced); E. H. McHenry, "Some Qualifications of Electric Railway Equipment for Trunk Lines"; R. A. Parke, "Braking High-Speed Trains"; W. B. Potter, "Electric Railways"; F. J. Sprague, "The History and Development of the Electric Railway"; L. B. Stillwell, "Notes on the Electrical Equipment of the Wilkesbarre and Hazleton Railway Company"; H. G. Stott, "Central Station Economics and Operation"; W. J. Wilgus, "Equipping the Central

Terminal." Section G.—Electric Communication (Chairman, Mr. F. W. Jones; secretary, Mr. B. Gherardi): Señor Don Julio Cevera Baviera, "Electric Communications in Spain"; Dr. J. A. Fleming, F.R.S., "The Present State of Wireless Telegraphy"; John Hesketh, "A New Danger to Lead-Covered Aerial Telephone Calbes"; Herr Joseph Hollos, "Simultaneous Telegraphy and Telephony"; Saitaro Oi, "Telephony and Telegraphy in Japan"; V. Poulsen, "System for Producing Continuous Electrical Oscillations"; G. de la Touanne, "Questions Connected with Rates and Management in a Telephone Exchange"; J. C. Barclay, "Printing Telegraph Systems"; Dr. Albert C. Crehore, "Rapid Telegraphy"; Dr. Lee De Forest, "Wireless Telegraph Receivers"; Patrick P. Delany, "Rapid Telegraphy" Hammond V. Hayes, "Telephony"; Franz J. Dommerque, "The Telephone Problem in Large Cities"; Reginald A. Fessenden, "Wireless Telegraphy"; J. C. Kelsey, "Features of Two-Strand Common Battery Systems"; Kempster B. Miller, "Problems. Automatic vs. Manual Telephone Exchange"; F. A. Pickernell, "Telephony"; Louis M. Potts, "Printing Telegraphy"; Col. Samuel Reber, "Military Use of the Telephone, Telegraph and Cable"; Prof. George F. Sever, "Electrolysis of Underground Conductors"; L. W. Stanton, "Economical Features in Modern Telephone Engineering"; John Stone Stone, "The Theory of Wireless Telegraphy."

Miscellaneous.

Atmospheric Radioactivity.

In a paper recently published in the *Physikalische Zeitschrift*, H. A. Bumstead shows that the radioactivity taken by a negatively charged wire exposed in the open air is mainly if not wholly, due to the activity induced by radium and thorium. In the case of a three hours' exposure, 3 to 5 per cent. of the total initial effect are to be ascribed to thorium activity, the ratio obviously depending on the greater or smaller readiness with which the emanation will escape from the ground. In the case of an exposure lasting 12 hours, the thorium activity will sometimes amount to 15 per cent. of the total value, while in the case of a long wire its decay may be watched for several days. It seems as if there were, in addition, a small amount of more rapidly decaying activity; experiments so far made do not, however, suffice to definitely settle this question. The radioactivity of rain and snow is probably due to radioactivity induced by radium; the absence of a thorium effect could be accounted for on the hypothesis that the rapid decay of the thorium emanation prevents the latter from reaching in any appreciable amounts the height where rain drops are formed.

Showing the Presence of Argon in Atmospheric Air by Spectrum Analysis.

It is well known that while the sensitiveness with regard to spectrum analysis is not diminished in the case of the light metals by the presence of other substances, the behaviour of nitrogen, hydrogen, argon, helium, &c., is quite different in this respect, mercury vapour even in small amounts being quite sufficient for instance to diminish the brilliancy of the nitrogen and hydrogen spectra, and even to bring about extinction.

Now according to Mr. Lilienfield's recent researches, recorded before the meeting of July 28 of the Prussian Academy of Sciences, the sensitiveness of mixtures with respect to spectrum analysis may be highly increased by using instead of glow discharge other forms of electric discharges. An ordinary oscillation circuit consisting of a capacity and a self induction of convenient magnitude was used, and an electroless Salet tube, with a capillary portion inserted in parallel to the self induction. The light emission from the capillary part of the tube was observed by exciting the vibration circuit, with an induction coil, when a considerable increase in the sensitiveness of the above reaction was noted. The 1 per cent. of argon contained in atmospheric air, was, for instance, readily evidenced. The air and argon spectra were next photographed jointly, when the air spectrum was found to contain both the line spectrum of nitrogen and the argon spectrum.

On a Secondary Radiation Produced in Metals by Radium Cathode Rays.

A series of interesting experiments is described by F. Paschen in *Physikalische Zeitschrift*. On the sensitive layer of a commercial silver bromide jelly dry plate there were placed platinum sheets of different thickness beneath black paper, pure radium bromide, sealed into glass, being arranged at the distance of 15 to 25 cm. above, when a silhouette of the metal sheets was obtained. When placing the platinum sheets below the layer of the photographic plate and in contact with the same, the radium lying at 15 cm. above, the cathode rays, would first traverse the glass of the photographic plate, afterwards the sensitive coating and finally strike the platinum sheet. Now, an intense darkening, reproducing the shape of the sheets, was observed on the plate. When introducing the radium glass into a closed lead cover, the darkening was found to be enhanced, while in the arrangement of the experiment first referred to, the shadows of the metal pieces were found to be less bright than before. In these experiments a secondary radiation from the metals struck by β and γ-radium rays is found to be operative, its intensity diminishing with the speed of the primary radiation. Experiments have been commenced with a view to investigating the connection between this secondary radiation and any controlling conditions. As β-rays may be considered as cathode rays, the secondary radiation whose existence has thus been established, may be regarded as the Röntgen effect of these rays, as required by theory. In accordance with modern views this effect proves the more intense as the speed and electromagnetic inertia, *i.e.*, the "impulse" of these rays is greater. The fact that γ-rays show by far the strongest effect of this kind is accounted for on the hypothesis that these radiations, so far from being Röntgen rays, are cathode rays of a very high velocity.

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ON PRIME MOVERS.

WHILE electricity supply is dependent upon dynamo electric machinery, the relative efficiency of prime movers will be of vital importance to it. In no industry at the present time has the prime mover so marked an influence on commercial progress as in our own, and in no period of the history of electrical engineering has the subject claimed so much attention. It is true that all electrical pioneers were busy perfecting the then reciprocating steam-engine, adapting the improved types to their particular purpose, but as a consequence of their labours standardisation has set in, and, with little or no further improvement to make, the situation has resolved itself into producing and selling these standard designs. An increase in the output of single generating units to figures once thought impossible has imposed limits on the construction of reciprocating engines, and some other means of driving has of necessity been resorted to. A second factor in the prime-mover question has thus been introduced in the form of the steam turbine. Such rapid strides have been made in the manufacture of this type of engine that makers of reciprocating engines have either arranged for its direct production or have set about still further enhancing the value of their old designs. At present it may be said that old-established British firms have adopted the latter policy, rather than the former, though there are indications of experiments with turbines being made. Powerful American and German combinations have, however, arisen recently for the purpose of exploiting one or other of the various existing designs of turbines. Appearances point to vigorous competition between turbines and reciprocating engines for medium powers, in the immediate future. As to which will prove victorious to the extinction of the superseded type it would be difficult indeed to prognosticate. Optimists find room for both designs in future power houses, while pessimists are not wanting to consign one or other machine to the scrap-heap, on presumably excellent grounds. The wide differences of opinion held on the respective merits of the two above types of prime movers have no appearance of settling the matter one way or another, and the situation becomes even more aggravated when we consider that the internal combustion engine must be reckoned with in the argument. Despite the economies of the triple-expansion engine—economies which from some recent tests have brought the engineer's dream of a horse-power from a pound of coal in sight—and the simplicity of the steam turbine, the internal combustion engine leaves all its competitors far in the rear when operating under improved conditions with produced gas. Neither the steam reciprocating engine nor the turbine clothed in their most elaborate guise can hope to approach the efficiency of the internal combustion engine, but the latter has a mill-stone round its neck

in the shape of cooling and lubrication troubles. We are consequently faced with a prime-mover problem whose solution gives rise to much speculation, though with little or no intimation of the result. Existing conditions compel the retention of the steam-engine, in no matter what form, for electric-supply purposes, and with the tardy development of the large gas engine there is little immediate hope of its replacing steam. The three-cornered fight now being waged between the respective advocates of both types of steam-engines and gas-engines will be productive of at least this amount of good: that the customer will receive the best that skill and ingenuity, spurred by keen competition, can devise, in either one or other of the respective machines. Although the steam-engine is so notoriously inefficient, and the gas-engine has such an economic reputation, the difficulties in perfecting both types will be sufficient to keep them in our midst for some considerable time, and meanwhile the consumer benefits as in justice he should do. Of course until the knotty point of prime mover is definitely settled in favour of one particular type to the rejection of all others, the sight of seeing stations out of date by the time they are completed will continue to be common, and the station scrap-heaps will have been increased by many important if weighty contributions. In the steam turbine we have reposed considerable faith, more than was ever bestowed on its reciprocating prototype, and we are being led into adopting it on a very large scale. On the other hand, reciprocating units no whit the smaller are being erected with the same confidence of results as of old, and their builders continue to flourish. With both these, widely different dynamos are used, namely, light and compact for high speeds, and heavy and extensive for slow speeds, and the manner in which both types of prime mover have been accommodated with suitable generators speaks well for the flexibility of the latter, and the patience with which they have been adapted to the exigencies of the case. If the gas engine is really to take the place of the steam unit the change were better made soon, as the heavy dynamo electric machine is now in vogue. Further developments with turbines will give the lighter generators a hold which will not be readily shaken off, and which for economic reasons might with advantage be retained. The heavier machines for slow speeds will not be built in such quantities, and as the present gas-engine can be coupled to no other form of generator the advisability of introducing it now is obvious. We do not say that the huge multipolars inseparable from slow speeds will be entirely discarded or impossible of manufacture in the future, but we should certainly deprecate their reappearance in any quantity to replace the compact turbo-generator. This aspect of the question may not have immediate bearing on the prime-mover problem, but it is bound to influence it as matters proceed. At present the "truimvirate" will reign, but the survival of one only of the three rulers must ultimately result. That strenuous efforts will give the victory to the internal combustion engine we do not doubt, but it is too soon yet to perceive that type of prime mover evolved from its predecessors which shall embody in a single unit the advantages now widely distributed over so many different types.

SINGLE v. POLYPHASE POWER TRANSMISSION LINES.

Engineers on the Pacific Coast of the United States are acquiring an experience of power transmission schemes, their installation and operation, which is probably not vouchsafed to many other engineers in the world. They are surrounded by mountains, whose western slopes almost border the sea, and whose eastern ranges are none the less available for power production by natural means. This "little spot" has become the home of high-voltage power transmission, and it can claim more plants operating in close proximity, in many cases in conjunction, than can any other. The longest and highest voltage plant is operating in its midst, and incidents the like of which might raise our hair on this side are of daily occurrence in the district. Once a year the engineers

of the country around meet in solemn conclave to discuss their trials and troubles of the twelve months elapsed, to put on record any great feat accomplished, and to say what shall or shall not be done in the "future" which may represent the next twelve months, in the way of power transmission work. Under the title of the Pacific Coast Transmission Association it holds these meetings, and its deliberations this year, on June 21 last, were, as usual, marked with many items of more than ordinary interest. We have already referred to a few of the papers presented for discussion, among others being one on an 80,000-volt transmission, particulars of which we gave last month. There was, however, one paper which we have been compelled to hold over after the proceedings came to hand and which we could not dilate upon until the present issue. This was entitled "Possibilities of Single-Phase Currents in Electric Power Transmission," the authors being H. A. Bullard and S. Spruut. The paper seems almost heretical from a quarter so hopelessly committed to polyphase working, but its deductions, though unlikely to carry conviction, are none the less important, and worthy of more than usual notice. The authors point out, firstly, that single-phase was first in the field and only remained in the background for want of a good motor. With the large number of polyphase plants they had nothing to do except to encourage their owners with hopes of materially increasing their output were they ever converted to single-phase. It is, then, proposed to show that a single-phase plant can be operated on more economical lines than polyphase, and also that cheaper installation can be effected. Through various deductions, the authors then proceed to show how prime movers, foundations, and buildings would naturally remain the same under single-phase working. For generators, the increase is to be from 58 per cent. for small machines to 32 per cent. for large, but this initial damper is removed by the assurance that "the actual money invested in generators is a very small item in the entire cost of equipment and in the light of the savings we expect to show throughout the rest of the equipment this extra cost sinks into insignificance." High voltages at the generator are promptly disposed of by the use of step-up transformers and the switchgear effects an economy of 25 per cent. in favour of single-phase, this allowing for the extra currents carried and the economies in floor-space. In the matter of transformers there would be no increase in costs with single-phase, and special provisions would admit of considerable reductions being made. For small motor and lighting transformers a saving of from 50 to 15 per cent. was possible with single-phase. Rotary converters, synchronous, and induction motors, where used, would be equally as cheap and satisfactory on one- as three-phases. As to street railway and main-line traction work the present energy displayed by manufacturers in developing a practicable single-phase motor was sufficient argument in its favour. In the matter of transmission line and equipment a very different tale was told. Three methods were suggested, metallic circuit, one line and buried return cable, one line and earth return, the latter to be procured by sinking artesian wells at generating and substations. With polyphase lines the triangulation of the wires increased the pole length by three to five feet and forty poles per mile was the average practice. With single-phase, this might be reduced to twenty-two, with spans of 250 ft. We reproduce a table which accompanied the paper, giving relative costs of the three schemes proposed, with a three-phase line. An examination of these shows that one overhead wire is cheapest and the return circuit could be obtained by either plan No. 2 or 3, or a combination of both. After dealing with the transmission lines the authors proceed to point out some possibilities of single-phase which are best summed up in their own words. "The feature of the grounded return would not increase the cost of insulators, as might at first seem likely, for an ideal condition is obtained, namely, a single insulator on the top of a single long pin—the pole. Nor would it increase the cost of insulating the main step-up and step-down transformers, since this very ground would be their protection by eliminating practically all sources of insulation break-down. All static accumulations on the line would be done away with, and the effects of capacity reactance, inductance, &c., would seem to

be neutralised or utilised as the case may be, and to an extent eliminating many of our present troubles on three-phase lines; 120 insulators should give about three times the trouble that forty-four would, and one wire would certainly cause much less trouble than three—bad boys, accidents, and the elements considered. Distributing or lighting and motor transformers would not necessarily have one side grounded, though it might be wise to connect one leg to the grounded leg of main step-down transformers. Present three-phase lines can be left as they are and used for single-phase and the capacity of the line increased, as, for instance, by sinking artesian wells and thus making a ground. The three-phase generators would give 80 per cent. of their capacity on any one phase alone, and the capacity of the line would be increased by 50 per cent., this, of course, would call for an addition to the generator capacity of 62½ per cent." These deductions are worthy of every consideration and though we do not anticipate that any manufacturer, especially of polyphase machinery, will consider their practical application at the present time, we need still further experience with three-phase lines to ascertain their limits. and when these have been reached the opening which single-phase has so long waited for may be granted it to fill. We hope that day may not be far distant.

COMPARATIVE COST OF LINES PER MILE EXCLUSIVE OF COPPER.

Item.	Three-Phase Three Wire.		No. 1. Single-Phase Two-Wire Overhead.		No. 2. Single-Phase One Overhead and One Underground Wire.		No. 3. Single-Phase One Over-head Only.	
	No.	Cost.	No.	Cost.	No.	Cost.	No.	Cost.
Well for ground .	—	—	--	—	—	—	One to every 50 miles	$100.00
Poles . . .	40	$340.00	22	$187.00	22	$187.00	22	187.00
Cross-arms . .	40	30.00	22	16.50	—	—	—	—
Insulators . .	120	130.00	44	55.00	22	27.50	22	27.50
Pins . . .	120	18.00	44	17.60	22	8.80	22	8.80
Labour . .	—	40.00	—	34.00	—	27.50	—	20.00
Total . .	—	$578.00	—	$310.10	—	$250.80	—	$343.30

The World's ELECTRIC PROGRESS

Editorial Commentary of the Month.

Our Special Issue.

We are announcing in this number our intention to deal with the recent International Electrical Congress, the American Tour, and the St. Louis Electrical Exhibits in a special issue. This we shall make as complete as possible, so that the matter may form a concise record of all that has been seen and done in the home of power transmission schemes. The deliberations of so important an assembly of electrical men cannot fail to be of permanent value, consequently the matter relating to the International Electrical Congress will be of even greater worth when it is to be found in a single number, handy to turn to at any time. We trust our many readers and friends will do all they possibly can to make known our intention, though we are already assured of their hearty co-operation in this respect.

Single-Phase Motors.

The first instalment of Dr. Neithammer's article on single-phase commutator motors, which we publish this month will be found a useful *résumé* of the present position of this type of motor. The development of commutator motors for alternate currents is the direct outcome of a desire to produce a machine which shall approach as nearly as possible to the direct-current motor. The success of the latter has arisen from its high starting torque and general efficiency, its employment for railway work being the natural consequence of these desirable features. The demand for a simpler system for railway working, a system eliminating all rotative machinery between the generators and motors, has turned attention towards the improvement of single-phase commutator motors, and there is now intense activity in electrical circles to produce a reliable and efficient type which shall fulfil the excessive demands likely to be made upon it in railway service. Subsequent developments will show whether this form of motor will for railway work at any rate, replace the induction motor used in conjunction with a direct-current generator, or an air-compressor as in the Ward Leonard and Arnold railway systems respectively. There are still many difficulties to be surmounted before the single-phase commutator motor will satisfactorily perform all that is needed of it. Even when it is perfected to the degree now desired, there will still be a need for transformers on the car when a high-voltage line is used overhead. In our next issue we shall publish a further instalment of Dr. Neithammer's article.

Brighton Technical School.

Brighton has long been famous as a health-resort for the weary Londoner, and for its schools. Of the latter it may be said they enjoy a degree of popularity seldom extended to such institutions in towns of similar size. The Municipal School of Science and Technology, erected at a cost of £40,000, was commenced in 1895, finished at the end of 1897, and formally opened by H.R.H. the Duchess of Fife on January 8, 1898. Class-work was commenced in September of 1897, and instruction in some fifty different subjects provided. From the first the engineering department has met with much favour, and in 1903 it was decided to expend £4,000 on further equipment to cope with the ever-increasing demands on this department. The department is divided into three sections—

mechanical, civil, and electrical—and the course at present extends over two years, at the end of which time the level attained is that of the Intermediate B.Sc. in Engineering at the London University. A third year's course will shortly be added, and students will study more closely the branch in which they have elected to specialise. The equipment consists of a 30-h.p. compound condensing steam-engine by Marshall; a 22-h.p. high-speed gas-engine by Crossley; a 7-h.p. Tangye gas-engine; a 30-h.p. De Laval steam turbine, driving a pair of dynamos used for lighting and power purposes; a 30-h.p. Babcock and Wilcox water-tube boiler; a 50-ton testing machine by Greenwood and Batley; and the workshops are fully equipped with a fine set of machine tools, twenty-two in all. In the electrical section, amongst other things of interest we may mention a 22-b.h.p. 230-volt motor; a 15-b.h.p. 460-volt motor; a 5-k.w. rotary converter, transforming direct current at 230 volts into one-, two-, three-, or six-phase alternating; a pair of 5-k.w. 230-volt machines running as series, shunt, or compound dynamos or motors, arranged for the various efficiency tests; a 5-k.w. rotating field alternator, capable of generating one-, two-, or three-phase currents; a 3-b.h.p. induction motor; a 2-k.w. balancer set; a 4-k.w. shunt or compound dynamo; and transformers for one-, two-, and three-phase currents, varying in size from 1.5 to 6 k.w. Current is supplied to this laboratory either from the College generators running in parallel or from the town three wire-mains, at a cost of 1*d.* per unit on the time switch principle, the supply being automatically cut off between 4.30 and 8 o'clock during the winter months, and the classes are arranged accordingly. The whole of the equipment has been specially arranged for systematic testing, and for this purpose a very complete set of measuring instruments of the most approved type has been provided. At the end of their course students usually enter one or other of the great firms with little difficulty on advantageous terms, and in a short time we hope to give further details of this interesting equipment.

70,000 Volts Direct Current.

ELECTRICIANS are apt to congratulate themselves when pressures as high as 60,000 volts alternate current are reached and commercially applied with success, but what must be said of rivals in direct-current circles who think little or nothing of 70,000 volts. Our contemporary the *Electrical Review* (N.Y.) has just published (September 24) a remarkable article on some tests of direct-current machines at the above pressures, the tests being singularly successful. Three dynamos coupled in series were used, and together gave the pressure mentioned, the power being about 70 k.w., that is, a current of one ampere was produced at 70,000 volts. Sparking difficulties were experienced at the commutator segments, the potential between each being 500 volts, but after the failure of an air-blast a condenser was employed between each segment and further trouble was obviated. The tests were chiefly confined to the behaviour of certain insulators with this high pressure, as compared with similar or lower pressures alternate current. In almost every case, insulators failing with the latter were able to bear much higher voltages with direct current. We need hardly say that these tests were conducted by M. Réné Thury, whose valuable, not to say extraordinary, work in the face of current practice has yielded such striking results. Among these we may refer to the hydro-electric plant of St. Maurice to Lausanne, in which some 5,000 h.p. is transmitted at 23,000 volts direct current. His success in various directions has prompted him to attempt even greater things, and as a consequence he has made this further move, which is fraught with such vital consequences to power transmission. If the use of direct current be admitted for power work with a loss of 10 per cent. on the line and a weight of copper of 66 lbs. per e.h.p., 4,200 volts pressure will be needed for six miles and 42,000 volts for sixty miles, the use of earth allowing of doubling these distances for the same voltage, loss, and weight of copper, or the reduction by one-half of the line pressure. These results open up a field for speculation which may well make manufacturers of standard polyphase plant look to their laurels. The possibilities of economical power transmission

by direct currents must be welcomed as salutary rather than otherwise. We do not want to find the limits of commercial transmission pressures yet, though these seem well in sight with alternate currents.

The Question of Freight on Tramways.

THE remarks of Mr. C. R. Bellamy, in his Presidential Address to the Municipal Tramways Association, on the handling of freight on tramways, should be read in conjunction with a paper presented to the Utica Tramway Convention by Mr. L. W. Serrell on the "question of freight." Mr. Bellamy enters a plea that increased facilities be afforded for the transport of goods on electric railways and tramways in this country. Mr. Bellamy tells us what might be done if the law were put in motion and if local authorities would stir themselves. He prophesies good things for the agriculture of these islands when traffic reforms shall have been introduced, and makes his appeal strong, in every particular, to those directly concerned. We fear his call upon the Government is destined to fall upon deaf ears, for despite its opinions as to the municipal control of anything, its natural apathy to industrial progress would discountenance the pleadings of the most powerful advocate of reform. Mr. Serrell in his paper points, on the other hand, to what has been done in America in freight handling on electric tramways and inter-urban cars. For the year ending June 30, 1903, the freight receipts on all lines in New York State were $266,401, and in Ohio $140,070. The author of the paper gave further statistics of freight traffic and also indicated the chief barrier to further progress in this direction—the opposition of the steam railways to any proposal for the interchange of traffic with the "electrics." This, it was stated, is chiefly due to the associations formed by railway companies to maintain freight rates, representing combinations of interests which could not be easily fought. From his investigations Mr. Serrell found that the amount of freight business now possible on electric roads would not exceed $750 gross per mile of track per annum. He further considered that it was high time a freight traffic association was formed among electric railways to improve the present state of affairs. From these figures and statements it is clear then that the freight business in America, though hampered by seemingly foolish restrictions, is on a much better basis than our own; but we shall hope that the profitable experience of other countries in handling freight on light railways will find its reflex in some definite action among tramway men in this country.

The Premium System.

THE repudiation of the premium system by the Engineering and Shipbuilding Trades Federation is a matter for considerable regret. It tends to bring to light the methods of trade-union leaders in their desire to "level down" the standard of wages to that of the slowest workers. The arguments advanced against the system do not hold water, and further they have little in the way of experience of the system to support them. It would appear that they are anxious to reject it on superficial acquaintance, and that the body of opinion disapproving it was yet to be produced. The system, in whatever form it be applied, tends to get the best out of the workman, and his willingness to co-operate in improving the output reflects beneficially on his own head and that of his fellows. It is folly to beg that the standard set should be that of the poorest worker, or even of one who is neither good nor bad but a go-between. Obviously, the good workman himself in being encouraged to do his best does not respond half-heartedly, nor expect his efforts to be gauged by that of slower men. Trade unions may as well seek the philosopher's stone as endeavour to establish a level of intelligence in the performance of work. In seeking to provide for that great majority who are only average workers, they are quite within their rights, but their benevolence must not restrict output nor find expression in levelling down methods which ultimately reflect disastrously on all classes of workers. Until there is complete unanimity among all workers in

condemning the premium system, we cannot but feel that it serves its purpose; firstly, in promoting better feelings between master and man in heightening the interest of the latter in the former; and secondly, in applying that necessary stimulus to labour, without which it becomes a clog on the wheels of progress. Until trade unionists can inculcate better ideas into their supporters than those in which the masters are regarded as the enemies of labour, we shall look further afield for methods which will bind employer and employed closer together with bonds of mutual making and application.

Obituary.

It is with intense regret that we record the death of two prominent men in electrical circles, Major-General C. E. Weber, C.B., and Professor N. R. Finsen. With the former we are more intimately associated, as his life and work were closely bound up with electrical affairs from a very early date in the history of the science. After an active military career, in which he distinguished himself in India during the Mutiny, in South Africa at the time of the Zulu war, and in Egypt, his military activities closing in that country with the Soudan expedition of 1884–85. In 1870 he became one of the engineering staff of the Post Office, commanding the 22nd and 34th companies of Royal Engineers serving in the Postal Telegraph department. He was then made a divisional engineer of the Eastern, and subsequently of the Southern, Division of the Postal Telegraphs, and rendered yeoman service in the expansion of our great telegraph system. In 1870–71 he founded, with Colonel Bolton, the Society of Electrical Engineers, of which he was since either secretary or member of council. He played a prominent part in the Paris Electrical Exhibition of 1881, being also a member of the International Electrical Congress at Paris in the same year. Several other electrical exhibitions were also indebted to his services. In 1885 he was managing engineer and director of the Anglo-American Brush Electric Light Corporation, and subsequently was deputy chairman of the Chelsea Electricity Supply Co., Ltd., and chief engineer of the City of London Electric Lighting Co. The Institution of Electrical Engineers, which he co-operated in forming, was constantly visited by him, and he has left the stamp of his labours on its proceedings and meetings. The deceased and revered gentleman was in his sixty-sixth year.

In recording the death of Professor Finsen, we feel that the entire civilised world must sympathise in his decease. His life may be well reflected upon with the thought, "Physician, heal thyself," for in helping others he was unable to turn his healing powers upon himself. The world's history teems with similar instances of men, disease stricken and physically weak, who were veritable giants, of a strength which, alas! was not theirs to command, except for the good of their fellows. At the outset of his career Professor Finsen was afflicted with a combination of incurable maladies which despite their influence upon his health have not prevented his becoming a real benefactor of humanity. At Copenhagen University, in 1890, he obtained his doctor's degree, and in 1893 introduced his red-light treatment for small-pox. In this method only red rays are permitted to fall on the patient's skin, and scarring and secondary fever are thereby prevented. Our readers will doubtless recall the presentation of the first Finsen lamp for the treatment of lupus by Queen Alexandra to the London Hospital. Professor Finsen was an indefatigable worker, and maintained his faculties until the end. A post-mortem examination has revealed his disease as calcination of the pericardium. We add our sincere sympathies to those already extended to Mrs. Finsen in her bereavement.

We also regretfully record the death of Mr. Henry C. Payne, Postmaster-General of the United States, who died at Washington on October 4. Mr. Payne was in his sixty-first year, and began business as a clerk in a dry-goods store at Milwaukee. He was connected with several railway, electrical, and telegraphic companies, and was appointed Postmaster-General in 1902. It is unfortunate that his administration has recently been marked by some very serious scandals, which, although they left his personal reputation untarnished, have undoubtedly greatly

affected the credit of the United States postal service.

Automatic v. Manual Telephony.

THE activity displayed in America in perfecting automatic apparatus for telephone exchange work cannot fail to occasion some misgivings among makers of manual systems as to the ultimate survival of their methods. We have pointed out on previous occasions the growing increase of automatic telephony in America and the probabilities of its ultimate displacement of the manual. Every opportunity was afforded the English electrical engineers on their recent tour of seeing automatic exchanges in operation, and we shall hope to refer more fully to these in future issues. For the present we must regard the automatic as a very keen rival of the manual, and more particularly for large exchanges. For a 5,000-line exchange automatic operating will cost about almost £9 per line including telephones, while with manual operating the figure is certainly less—just over £6 per line, but tends to increase with the number of lines. The tendency is to instal the automatic on a very large scale, and in this sphere it would seem to better fill its particular functions. Moreover, the economies possible in staff reduction and building accommodation are more readily realised with the large exchange. Again, from a humane point of view the genus "manual operator" is hardly worth cultivating, seeing that the task of attending to a section of a large board must impose severe strains on the physical and mental constitution. On these grounds alone the automatic is to be welcomed, apart from the undoubted advantages of eliminating the personal element from work in which it is least desired. The use of the manual has certainly called into existence a branch of work which would not otherwise have existed, but this cannot be urged as an argument against the introduction of the automatic. It must not be forgotten that some operators will still be required, though the number cannot be regarded as any compensation for the displacement of what must be thousands of telephone exchange operators.

Is the Day getting Longer?

WE have received the following from Mr. E. Butler, and reproduce it as affording food for considerable reflection.

"That the time occupied by our world in its diurnal rotation can be slowly lengthening is, of course, not apparent to any one, although the fact remains irrefutable that the duration of our present day is much less than it was some millions of years ago. There are several natural physical causes tending to effect the gradual arrest of the earth's proper motion about her axis; the most important of these is the retarding effect of tidal action influenced by the sun and moon's attraction. The tides no doubt had an enormously greater effect during the early stages of the earth's career than at present. For while the retarding action of the tides still remains probably the greatest factor in the possible lengthening of day, it must be infinitely less than formerly whilst the globe was in a molten state, and at a still earlier period when in a gaseous condition. Under those conditions tidal action, instead of being limited to the waters of the oceans to a rise and fall of from 10 to 40 ft., must have had a comparatively tremendous retarding effect, the whole surface of the globe being in a liquid condition, the height of the waves caused by tidal accumulation could scarcely have been less than a hundred miles and the velocity of the currents surging from east to west have had an enormous retarding effect.

It would seem at first sight, however, that the immense energy stored in the rotation of a solid globe of some 7,925 miles in diameter and having a specific weight 5½ times greater than water, and revolving at a maximum surface-velocity of more than 1,000 miles an hour, could never be appreciably absorbed. An interesting calculation, notwithstanding, shows that the surface-velocity can be very slowly if inappreciably increased by even artificial means. In proof of this statement it is necessary at first to state the force stored up in a revolving globe of this size, *i.e.*, a mass of 2,591,000 million cubic miles capacity and 34,333,000 million tons in weight revolving at a mean velocity of 920 ft. per second, allowing for increased density towards the centre, this being equivalent to a mass of this

weight revolving in a circumference of 15,000 miles at the velocity of nearly 1,000 ft. per second.

"Now the force stored up in this great fly-wheel represents an accumulated energy equivalent to 455,000 billion foot-tons, or in other words about 30,333 billion horse-power. And in order to reduce the velocity of rotation of this mass by as little as one second, it requires that 10,000 million billions of tons of minerals be brought to the surface from a depth of 1,550 ft.; this calculation being based on the accelerating effect due to increased radius at a mean latitude of 50 degrees. Although it will require so vast an amount of material to be raised to such a height to produce this result, it does not follow that the effect of mining conducted on a greater scale may not have some appreciable retarding effect ultimately on the length of day. The total weight of material of all kinds mined at the present day, including coal and other minerals, together with the waste interstrata, aggregates upwards of 2,000 million tons annually, and the energy absorbed by this mass being raised from an average depth of 1,550 ft. will require the comparatively endless time of six billion years in order to retard by one second the duration of the earth's rotation, so stupendous is the force stored up in the vast mass comprised by a globe of nearly 8,000 miles in diameter and moving at a surface-velocity of over 1,500 ft. per second.

"A more probable cause for the lengthening of day must be looked for in another direction. On reference to a geographical globe it will be seen that as you move from the polar regions towards the temperate zones you increase your distance from the earth's axis at a much greater rate than in going an equal distance across the equator. So marked is this effect that it would only require 1,400 million tons of drift such as carried by the glaciers on their flow towards the equator from latitude 75° to a parallel of 55°, *i.e.*, a surface-distance of 1,380 miles, in order to increase the radius of rotation of this mass from 1,017 miles to 2,270 miles, consequently doubling its velocity; the energy absorbed in accelerating this mass would be sufficient to retard the earth's rotation by one second.

"There are other retarding causes—for instance, all mountains of volcanic origin have been thrown up as excoriæ from the earth's interior, and in being belched forth as ashes and lava have acquired a higher velocity of rotation. But the effect of all the material thrown up in this way is only small, as will be seen by computing the effect of all the cones raised by this means—approximating less than 5,000 ft. in mean height and to a total of 4,000 cubic miles in capacity, with a further equal weight of material spread over the earth's surface. Even after allowing all this material to have been raised from the depth of a mile, it will be seen that each ton raised by volcanic agency would have five times the retarding effect of one ton of minerals, as before considered, and the total effect of all the weight of material raised from this cause would only have had the effect of reducing the earth's period of rotation by half a second.

"An hypothesis that may be cited as indicating another factor in the several forces tending to retard the rotation of the terrestial globe is the generation of magnetic effects and electric currents from pole to pole, owing to its rotation in a magnetic field caused by the sun's influence. This action would, of course, absorb some energy from the vast store represented by the revolving mass constituting our world; but from due consideration of the various causes, real and conjectural, each tending to increase the length of day, one may still regard the laws of motion bearing on the future of our world as being immutable, and but for the fact of other planets having been arrested of all proper motion in the millions and millions of the past ages, one might safely consider it as being established that length of day will be for a very long time yet without change."

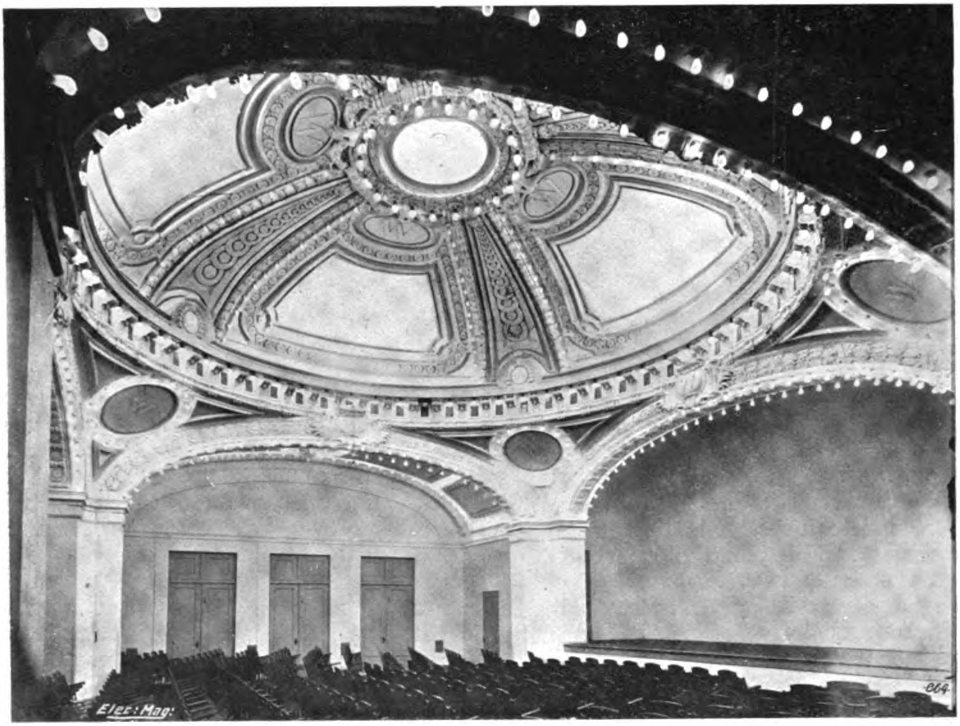
THE AMERICAN TOUR AND THE ELECTRICAL CONGRESS.

THE International Electrical Congress has been a huge success both from the points of organisation and technical interest. A glance at the extensive programme of papers read gives but a faint idea of the amount of work entailed both in their compilation and classification. We must extend our heartiest congratulations to the committee of electrical engineers responsible for this great gathering, feeling at the same time that they will have been fully repaid by the manner in which their labours have borne fruit, and by the enthusiasm displayed on the great occasion.

We announced it as our intention, in our last issue, to publish this month a detailed account of the entire proceedings, the Institution Tour, the International Congress, and the Exposition Electricity Exhibits, from the pen of our Editor-in-Chief, Mr. Theo. Feilden, but we have since decided that to do full justice to these important events nothing short of a special number will suffice. Again the time at the disposal of delegates and engineers on tour has been so limited that the detailed treatment we had in view for these subjects would have been impossible for this issue. In the interest of our readers in particular and electrical men in general, we shall issue the account we had in mind in November, and make it a full, complete, and faithful record of the entire proceedings such as will not be found in any single issue of any technical journal. We are giving this month a brief outline of what has actually transpired, but this will not in any way detract from the value of the special matter to be published later.

A full list of the English delegates and engineers participating in the tour and attending the congress was published last month, and we have already given particulars of the chairmen of the various sections under which the papers were classified. A full list of the papers read, or taken as read, will be found in the World's Electrical Literature Section at the end of this issue.

After its arrival at Boston on September 2, the English party on September 3 was shown over the supply system of the Boston Edison Co. (THE ELEC. MAG., No. 2, vol. ii., p. 137) in whose large L Street station much interest was taken. On the same date the Italian contingent from New York joined the party, and returned to that city with them on Sunday, September 4. On this day about five hundred members of the Institute and visitors were taken by steamer up the Hudson, and anchored at Dreamland, Coney Island, whence they did not depart until midnight. On the fifth a full day was spent in seeing as many of the New York stations as could be crowded into the time at disposal among others the Kingsbridge power house (THE ELEC. MAG., No. 2, vol. ii.) was inspected as well as the new station of the Interborough Rapid Transit Co., for supplying the subway trains. In the evening a grand banquet was given the Institution party, the Associazione Elettrotecnica Italiana and other visitors by the American Institute of Electrical Engineers, co-operating with the reception committee, at the Waldorf Astoria. President Forbes welcomed the visitors and President B. J. Arnold on behalf of the Institute expressed his pleasurable recollections of the reception accorded American electrical engineers in England in 1900, a circumstance which had made many lifelong friends among them and which added greatly to the intensity of the welcome now extended. President Ascoli and members of the Italian Association were similarly greeted. President Ascoli expressed great satisfaction at seeing so many representative men of the most important electrical societies gathered there for the purpose of furthering the interests and welfare of the industry. His appreciation of the



Westinghouse Auditorium Lighted by Mercury Vapour, Incandescent, and Nernst Lamps.

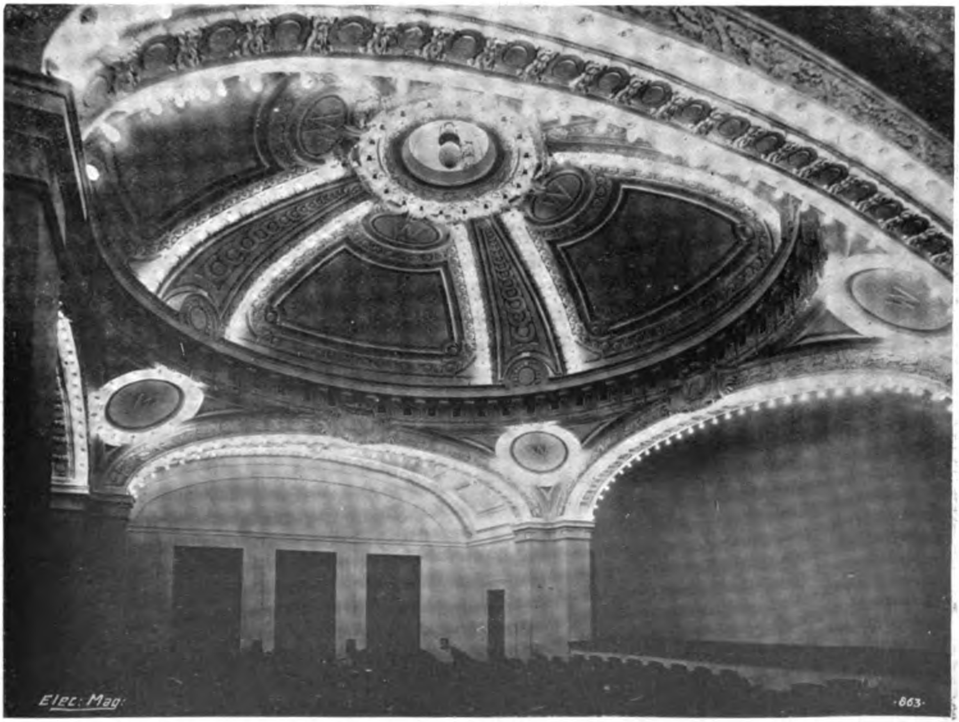
cordiality of their American friends was also given expression to. Mr. J. W. Lieb, junior, on behalf of the Institute reception committee, of which he is chairman, said that the same bounteous hospitality extended to electrical engineers in other countries would be everywhere accorded the visitors and in no professional or formal spirit they extended the hand of good fellowship. President R. Kaye Gray responding for our own Institution referred in pleasing terms to the visit of the American engineers to this country and expressed cordial thanks for the reception given the party. Other important speeches by prominent American and German electrical manufacturers were made before this elaborate function was brought to a close.

The circular tour arranged for the party was commenced early on the morning of the 6th, a special train conveying the party to Schenectady the first stopping-place. Here the mammoth works of the General Electric Co. were inspected in parties accompanied by guides. The large power house with a capacity of 12,000 k.w. in steam turbo-units attracted much attention. After seeing the 10,000 employees of the company quit the works the party was taken over a portion of the new electric line to Ballston, one of the cars being fitted with the new compensated single phase motors, for alternate current and direct current circuits, recently developed by the company. Train was then taken to Saratoga where dinner was partaken of. At 10 P.M. the party entrained for Montreal at which place a local committee with Prof. R. B. Owens at its head received the party. The Lachine Rapids were then visited and also the receiving station of the Montreal Light, Heat, and Power Co. A trip in special cars was also made through Montreal during the afternoon and at 4.30 P.M. the delegates were received by the Chancellor and Governors of the McGill University. On Thursday the day was spent at Shawinigan Falls seeing the Carbide Works and the power house, and in the evening departure was made for Niagara. This was reached at 9 A.M., and between that time and 6 P.M. the party visited the Falls, shot the rapids

and inspected the power houses of the Niagara Falls Power Co. and the Niagara Falls Hydraulic Power Co., also the neighbouring electro-chemical works. Chicago was reached the next morning Saturday, at 7.30 A.M., and after breakfast a general tour was made of the chief points of electrical interest in the city. Among these were the Fisk Street Station of the Commonwealth Electric Co., equipped with 5,000 k.w. Curtis turbines, the works of the Western Electric Co., the automatic telephone exchange (THE ELEC. MAG., No. 3, vol. ii., p. 221) and the tunnels of the Illinois Tunnel Co. The afternoon was spent in cruises on Lake Michigan or in automobile trips, the party leaving for Springfield at 11.45 P.M., and reaching that place at 7.30 A.M. Lincoln's Tomb was visited in trolley cars in the forenoon and the party subsequently set out for St. Louis arriving there in the afternoon of the same day.

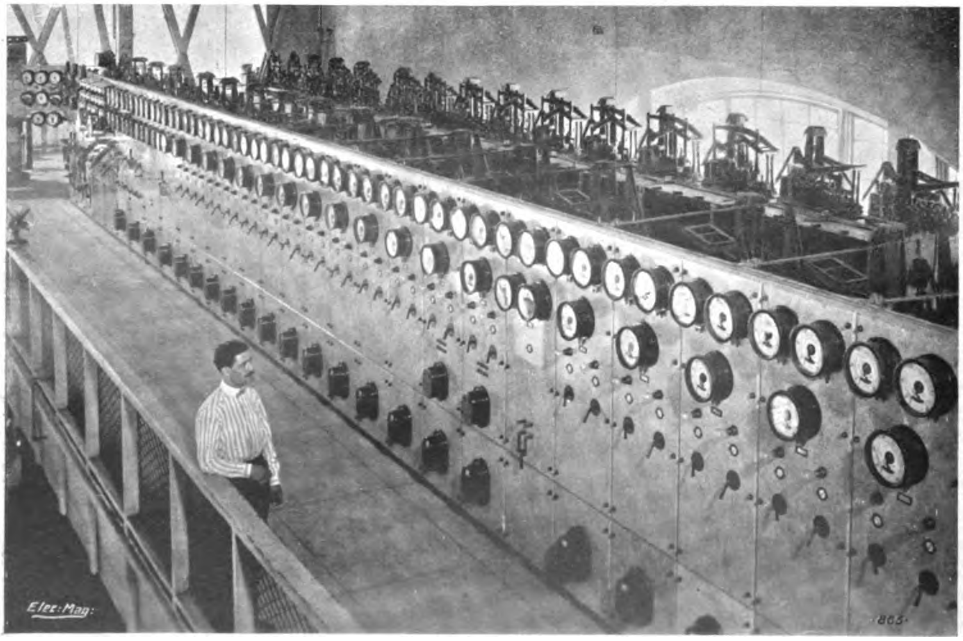
On Monday, September 12, the first meeting of the chamber of delegates was presided over by Prof. Elihu Thomson at the Music Hall. St. Louis, who introduced Hon. D. R. Francis, President of the exposition, to extend a welcome to the delegations. President Francis in the course of his remarks said :

" I think it will be a long time, in this country at least, before another universal exposition is attempted. There will, of course, be international expositions in special lines, and the line which you represent is the one in which there is likely to be another international exposition before a great many more years have rolled by. The great advances which have been made in the science to which you have given your allegiance has rendered more than interesting any assembling of the different appliances and any demonstration of the different inventions and discoveries that have been made by the members of this congress or by the members of the allied organisations. There was some argument, if I may term it such, in the organisation of this exposition as to whether electricity was entitled to recognition as a separate department. There was a claim made by the department of machinery that elec-

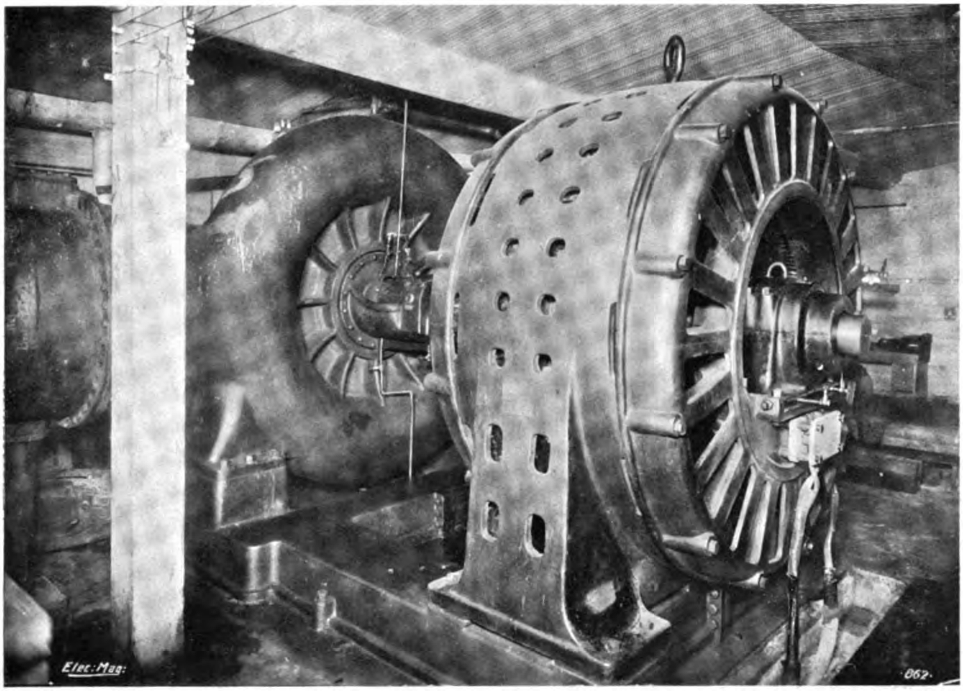


THE SAME BUILDING LIGHTED BY INCANDESCENT LAMPS.

trical appliances, when made instruments of utility, became machinery and consequently belonged to the department of machinery; and that there was no more occasion or necessity for a department of electricity than for a department of steam. I believe that those of you who will see the department of electricity which has been installed at this exposition will admit that the action of the administration of the exposition in determining that electricity should not only be a separate department, but should have the exclusive use of a large exhibit palace, was a wise conclusion. . . . The installation in the electrical department in this exposition is, in the judgment of the management, superior to any installation that has ever been given in any exposition. It is the result of the very faithful and intelligent efforts of the chief of the department of electricity. In so comprehensive an organisation as a universal exposition, you can readily understand that there must be a number of men who are trusted to do a great many things without consulting any higher authority. . . . We congratulate ourselves on the classification of these exhibits. You gentlemen who are readers and thinkers know how difficult it is to make a comprehensive classification, and a working classification, that will include all of the products of all the civilised countries on the globe. One of the departments of that division of exhibits, one of the great departments of that classification is electricity. We might call electricity the new science. The discoveries that are being made in it from day to day will no doubt necessitate another classification or sub-classification before another exposition is held, whether that exposition be universal or an international exposition of electricity. The wisdom that has been exercised by the organisers of this congress and by those who have kept it in existence from year to year indicates a great breadth of view and a remarkable foresight in regard to the development of electricity. The different branches of this congress all demonstrate how far-reaching are the discoveries in electricity. St. Louis is glad to be made the scene of your fifth congress. The exposition management feels honoured that the time and place of your meeting should have been influenced by the preparations that were made by the exposition for the purpose of bringing together the best



LARGE SERVICE PLANT SWITCHBOARD.



2,000-H.P. INDUCTION MOTOR DRIVING CENTRIFUGAL PUMP FOR CASCADES.

products of all the peoples of the world. Permit me, on behalf of the exposition management, to express the hope that your deliberations may come fully up to your expectations ; that you may visit the exposition exhibit of electricity ; that your gathering here may be prolific not only of pleasure to yourselves, but that it may result in still further advances in the line of progress which you have pursued with such remarkable vigour and success during the last decade." The following is taken from *Electrical Review*, N Y.

At the conclusion of the address by President Francis, Chairman Thomson called attention to the fact that the committee of organisation substantially finished its work on this occasion. In recalling some of the past history which led up to the organisation of the congress, Professor Thomson said :

" The four-hundredth anniversary of the discovery of America was celebrated in 1893 by the establishment of a great exposition. The Chicago International Electrical Congress, the work of which is doubtless familiar to many of those present to-day, was the first great gathering of electrical students and workers held in the Western Hemisphere. A little over one hundred years ago the then youthful but ambitious republic of the United States of America acquired from France by the expenditure of $15,000,000 purchase money the possession of an enormous territory extending from the shores of the Gulf of Mexico, west of the Mississippi River, northward and westward to the Pacific coast. The northern limit was undefined, and was settled long after by treaty with Great Britain. The tract includes every variety of farm land, forest, semi-arid, and arid land. Much of the arid land is amenable to irrigation. The agricultural and mineral wealth is beyond estimation. The Louisiana Purchase must be regarded as an event not less important than any other in the history of this great nation, fitly to be celebrated after one hundred years by a great exposition, showing the results of human activity and progress in the arts, sciences, and engineering—and might I add, especially in electrical science and engineering —the first in the new century just begun.

" It was natural that an international

electrical congress should have been deemed desirable. Accordingly, a committee of organisation was called together by the exposition authorities. The committee in undertaking the work realised that the task was not a light one, and invoked the aid of the American Institute of Electrical Engineers and the other societies which have affiliated themselves with the congress. The work of the committee of organisation is completed by this meeting, and the choice of permanent officers is now in your hands."

Professor Thomson paid a warm tribute to Dr. Arthur E. Kennelly for the time and effort which he had spent in the development of the congress. He also called attention to the valuable work of Mr. W. D. Weaver, and thanked the various scientific and technical bodies for their assurances of co-operation and their representation. Chairman Thomson then called upon Mr. R. Kaye Gray, president of the Institution of Electrical Engineers of Great Britain, to respond on behalf of the British Institution to the address of President Francis. Mr. Gray stated that he could say for the Institution of Electrical Engineers of Great Britain, that they felt very much pleased when they received the invitation to go to St. Louis and to take part in the International Electrical Congress. This pleasure was made the greater when there was received from the American Institute of Electrical Engineers a cordial invitation to become their guests. Another pleasure which had been experienced in the United States since their arrival was the meeting with the colleagues from Italy. Never before, said Mr. Gray, had such a programme been laid out as had been prepared for this congress. Any one who had at any time taken part in the organisation of meetings, though of very much smaller proportions than this congress, could well appreciate what an enormous amount of labour had been expended. He had heard how much Dr. Kennelly and how much Mr. Weaver had done, and he wished to take this opportunity, while he was in command of the platform, to break through the veil of modesty which was so well known in Professor Elihu Thomson, and give to him his due meed of praise.

Chairman Thomson, in introducing Professor Moise Ascoli, president of the Associazione Elettrotecnica Italiana, said that there was not only a splendid representation from the Institution of Electrical Engineers of Great Britain, but a most unusual representation from the Italian association.

As the head of this delegation, Professor Ascoli said that it was an exceptional fact that so considerable a number of Italian engineers should join in a visit to the United States. It was the first time, he thought, that such a large delegation had visited this country. The delegation already had a splendid proof of the hospitality and of the sentiments of friendship from the Americans who had entertained them in the past few days. They had an opportunity of seeing and highly appreciating the great results of organisation, which was the special characteristic of American work.

Professor Thomson called upon M. Guillebet De Nerville to speak, not only on behalf of France, but on behalf of other nations which were represented to a greater or less degree. M. De Nerville addressed the meeting in French, and expressed his pleasure in being in attendance on the congress.

Professor W. E. Goldsborough, chief of the department of electricity, was called upon to speak relative to the magnificent installation of electrical exhibits. Professor Goldsborough spoke at some length concerning the various installations, and the part which they represented in the historical presentation of the development of electrical engineering. On the part of the electrical men of St. Louis, he extended a very cordial welcome to the delegates and members of the congress.

For fuller details of this important gathering see our St. Louis Souvenir Number (November).

SPECIAL ARTICLES

SINGLE-PHASE COMMUTATOR MOTORS.

Prof. Dr. F. NIETHAMMER.

ALTERNATING - CURRENT commutator motors, which have become of the utmost importance for railway work during the last year, were built in the period between 1880 and 1890 by various inventors and manufacturers. Before three-phase currents were generally used, single-phase commutator motors were designed and perfected by Ganz and Company, Budapest, mainly by Blathy and Deri, by Siemens and Halske (1886), by the Helios Electrical Company, Cologne, by the Maschinenfabrik Oerlikon (Prof. Arnold), by Eickemeyer, assisted by Steinmetz, and last, not least, by the Thomson Houston Company (1887). To E. Thomson of this company we owe the repulsion motor, the rotor of which is short-circuited without any connection to the line. The types of all other concerns were series motors, the field and armature of which were both connected to the line.

In 1888 Wilson took the English patent 18525, describing a two-phase commutator motor the armature of which was provided with a commutator with four brush sets for two poles. About 1891 Görges, of the Siemens and Halske Company, made some tests on a three-phase commutator motor arranged as series and as shunt motor. He then stated that the power factor could be brought up to unity for certain positions of the armature brushes, and that by a wide range of brush shifting a very economical variation of speed could be effected. The action of the commutator as a frequency changer was clearly recognised. But the unrestricted triumphs of the asynchronous polyphase motor, especially in its simplest mechanical shape with squirrel cage checked progress in commutator motors, subsequent to 1892, as troublesome commutators and their sparking had already a bad reputation in direct-current machines. Small motors up to 20 h.p. were, however, built at this time by various firms, mainly by Ganz and Company, Helios Company, Schneider Creusot, Wagner Company, St. Louis and the Austrian Union Company. Ganz and Company applied to their series motors of 1892 all the schemes mentioned and patented again during the last few years.

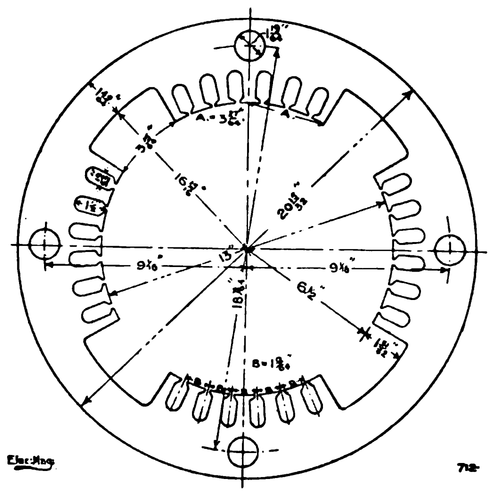


FIG. 1. GANZ LAMINATED POLE MOTOR

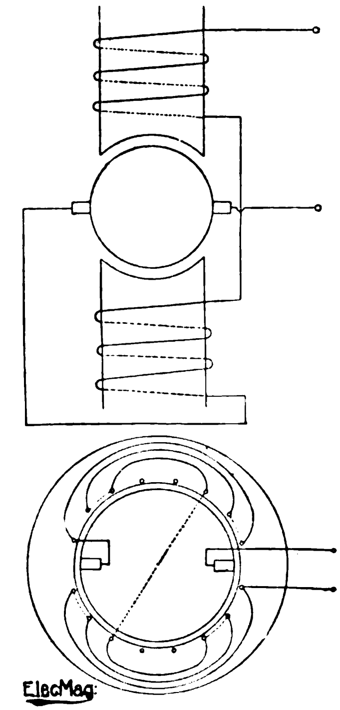
The laminated pole-shoes of the 42-cycles Ganz motors* were perforated by slots (Fig. 1), carrying a short-circuited coil to damp away the crossfield, between armature winding and commutator bars resistances were used which sometimes were imbedded into the slots, and the armature voltage was higher than the field voltage by 30 per cent. Eickemeyer used a ratio of armature to field turns of 4 : 1 in 1892. In a patent granted to Blathy a series transformer for the armature circuit and a switching device to vary the number of the field coils was already claimed. Between 1895 and 1898 Atkinson took many valuable patents on single and multi-phase commutator motors (*vide Trans. Civ. Eng.* 1898).

The extensive use of the asynchronous induction motor revealed, however, many drawbacks of this commutatorless motor type, viz., the impossibility of starting the squirrel-cage motor against heavy loads, and the lack of an economical and simple method of speed variation. For electric traction and crane work, the induction motor was ne er a real rival to the direct-current motor. In addition, the direct-current machine had been brought to a high degree of perfection and the prejudice against the commutator then overcome.

* Kenelly used this device also long ago.

The new epoch of alternate-current commutator machinery was opened by Heyland, but without much practical success, as he applied the commutator only for compensation of lagging currents and for compounding generators, and mainly for polyphase machinery. For the same purpose the commutator has already been proposed by Leblanc, Boucherot, and Latour. In about 1902 Winter Eichberg, the Société Alsacienne, Belfort and Sautter, Harlé et Cie described economical methods for the speed variation of polyphase commutator motors by applying transformers which regulate both voltage and phase of the commutator. For electric traction this motor was, however, handicapped by the drawback of two to three trolley lines against one for single-phase or direct-current.

The most recent period of single-phase commutator motors for traction work was opened by the Westinghouse Electric and Manufacturing Company (Lamme) in



Figs. 2 and 3.

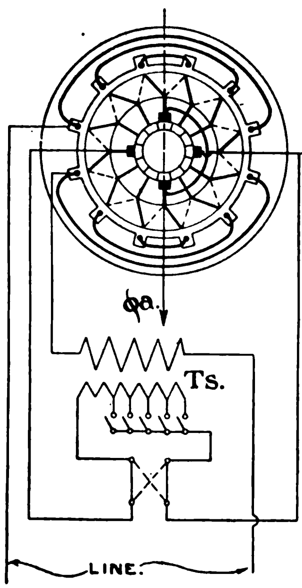
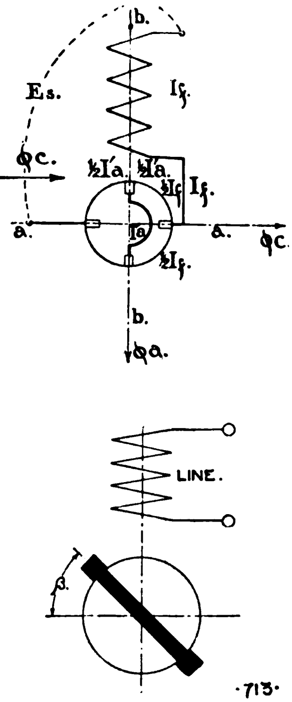


Fig. 6.



Figs. 4 and 5.

1902, referring to the straight series motor. Dr. Finzi followed very soon with results obtained on a street railway series motor of 27 h.p. In 1903 Eichberg gave full particulars of the compensated commutator motor of the Union Company, Berlin, and the General Electric Company published data on repulsion motors for traction work. To-day all important concerns are developing single-phase commutators motors. Of more recent design still are the Schüler-motor and the Fynn-motor (1902), which represent a combination of the repulsion motor for starting and the slip-ring motor for running.

At present the following types of single-phase commutator motors have only to be considered:

(1) The *straight series motor* with a direct-current armature; the laminated field may either have definite poles and concentrated winding (Fig. 2), which is preferable, or a distributed winding embedded in slots (Fig. 3).

(2) The *repulsion motor* (Fig. 4) with a distributed field winding and a direct-current armature, the brushes being shifted by about 70° from the neutral zone and short-circuited amongst each other.

(3) The *compensated commutator motor* (Fig. 5), being a series motor to which a second set of brushes, short-circuited as in the repulsion motor and lying just between the main brushes, is added.

(4) *Transformer motors* with a series transformer to interlink the armature of the series motor (Fig. 6) or of the compensated motor (Fig. 7) with the field and line circuit.

(5) *Combinations of commutator motors* for starting with usual asynchronous motors for running. This type is not intended for railway work but for stationary constant speed purposes:

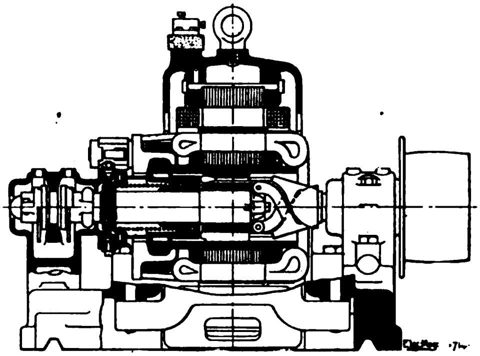


Fig. 7. Wagner Motor.

(*a*) The *Wagner motor* (Fig. 7) starts as a repulsion motor; near synchronism a centrifugal governor short-circuits all the radial commutator bars by a metallic ring. The motor starts without any starting device against heavy overloads with moderate current; by using ohmic starting resistances one and a half times the normal torque may be got with normal full-load currents. Figs. 7A and 7B show the characteristic curves of a Wagner motor for 3 h.p., 1,500 revs. per min., 220 volts, 50 cycles; Fig. 7A for working condition (asynchronous motor) and Fig. 7B as repulsion motor

(*b*) The *Dérimotor* of the Austrian Union Company is also started as a repulsion motor with resistances *b* in the connections to the commutator bars. At the end of the starting period the connections of the primary winding are changed in such a way as to vary the number of poles *f.i.* from 2 to 4 (Fig. 8). This has the effect that the armature currents pass through other end-connections than before, avoiding the commutator and the

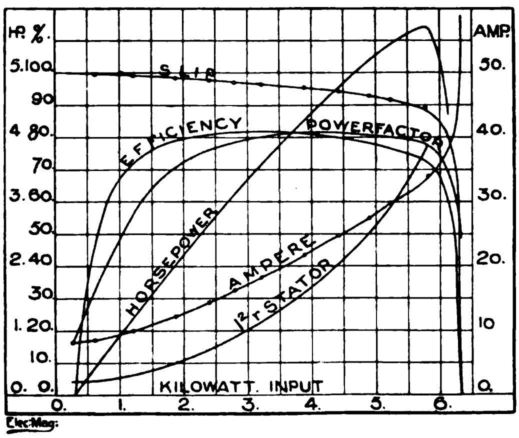


Fig. 7A.

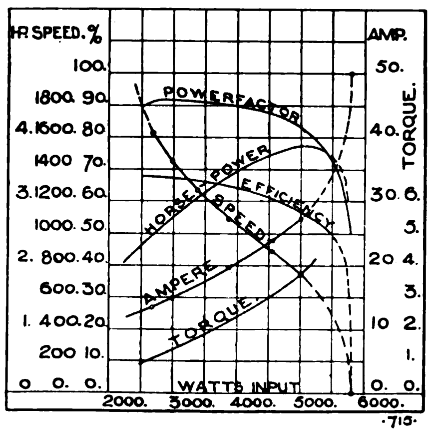


Fig. 7B.

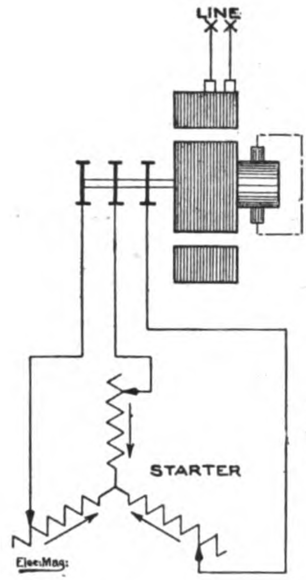
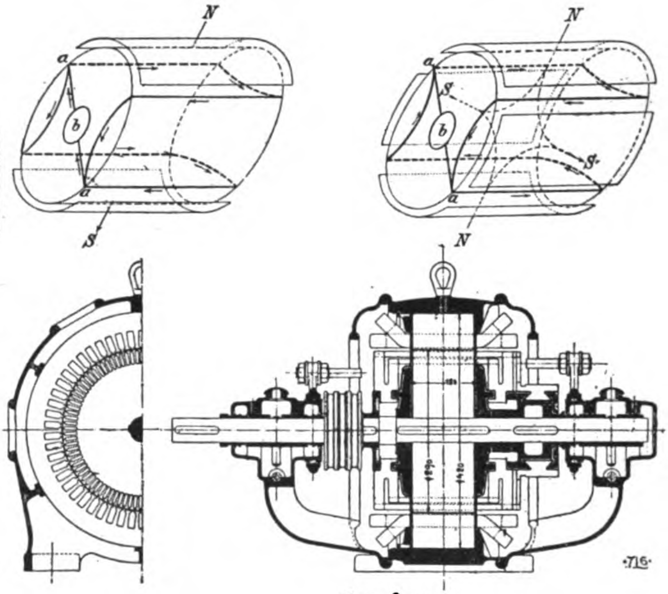


FIG. 8.



FIGS. 9 AND 10.

re istances; the motor becomes a pure induction motor. Reversing is effected by brush-shifting.

(*c*) The *Schülermotor* (Figs. 9 and 10) has the same stator as all three-phase induction motors, two phases only being in the circuit at a time. The armature with a direct-current winding is provided with a commutator on one side and with three sliprings on the other. When starting, the slipring circuit is open and the motor works as a repulsion motor, gradually resistances are inserted across the three sliprings, which are by-and-by short-circuited, transforming the repulsion motor steadily into a usual induction motor without any current rush. The motor is reversed by brush-shifting or by replacing one of the three stator phases by another one. The *Fynn-motor*, built by Alioth, Switzerland, closely resembles the Schülermotor, it has, however, an additional three-phase armature winding connected to the main armature winding at three equidistant points.

The single-phase *shunt* motor has never been used to any extent; the same is true so far of the *three-phase* commutator motor, though the latter deserves to be seriously considered. The method of varying the rotor voltage and phase for a multiphase commutator motor is to be seen from Fig. 11 of the Berlin Union Company. For all speeds the power factor approaches unity closely, and the efficiency is always higher than about 80 per cent. The vector diagram, which clearly explains the working of this compensated motor, is represented in Fig. 12, in which all magnetic fluxes Φ and ampère-turns AT are rotary fields; all currents I, voltages E, and resistances R are to be taken per phase. This is a short explanation of the diagram: Φ_2 = magnetic flux in the rotor, I_2 current in rotor and brushes, $\Phi_s'' = C.I_2$ strayfield in the rotor,* $\Phi_s'' \parallel I_2$; Φ_g = flux in the airgap, the magnetising current I_μ lies on the vector Φ_g, the same is true for the ampère-turns AT producing the flux Φ_2, Φ_g, and Φ_1. From the secondary ampère-turns $AT_2 = c.I_2$ and $AT = c.'I_\mu$, the primary ampère-turns AT_1 result. The primary current $I'_1 = \frac{AT_1}{c'}$ has the same direction as AT_1. $\Phi'_s = C.'I'_1$, and $\parallel I'_1$ is the primary strayfield which is added to Φ_g to get Φ_1, the primary flux. Add the primary counter E.M.F. $-E_1$, which is perpendicular to Φ_1, and the ohmic drop $I_1 r_1 \parallel I_1$, to find the terminal voltage E_1; combine I'_1, with the current $I_1 = \frac{\text{iron and friction losses}}{E_1}$ to get the whole primary current I_1, the angle between E_1 and I_1 being ϕ. The rotor voltage induced by Φ_2 is E_2 perpendicular to Φ_2,

* $\parallel$ means "parallel to."

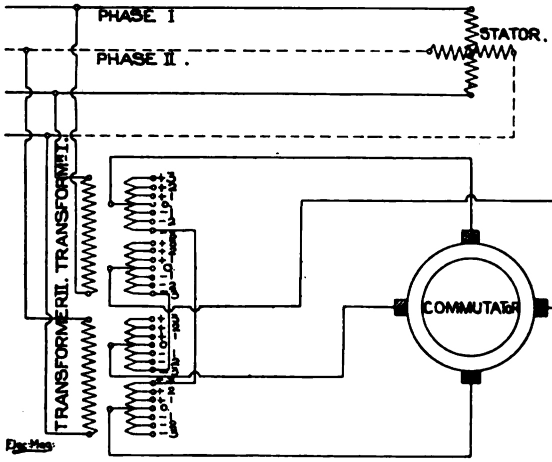


FIG. 11.

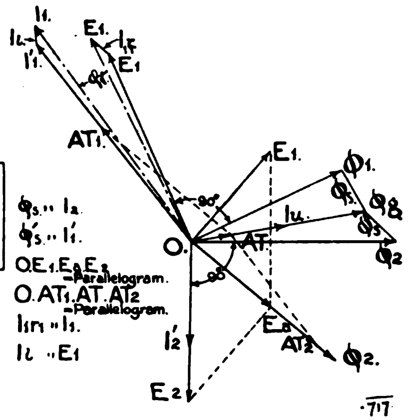


FIG. 12.

the impressed rotor voltage from the transformer is E_1, combine E_2 and E_1 to E_a, which gives rise to the secondary current $I_2 = E_a\, r_2$.

If there are other circuits inside the rotor besides the commutator and brushes *f.i.* resistances between commutator bars (Heyland), the current I'_2 in these circuits must be added to I_2.

To cover the *theory* of all types of single-phase commutator motors at once, the general case represented in Fig. 13 is assumed. The armature may have Z_a effective conductors, 2a parallel circuits, 2p poles, a current I_a and a potential difference across the brushes of E_a. The brush angle against the neutral zone is β, the field has Z_f effective conductors, that is, $1/2\ Z_f$ turns and a current I_f. The armature ampère-turns $AT_a = \frac{I_a Z_a}{8\,ap}$ may be split in two rectangular components: $AT_c = AT_a \sin\beta$, the cross AT in the direction *aa* and $AT_g = AT_a \cos\beta$, the counter AT in the direction *bb*. AT_g, together with the field ampère-turns $AT_f = Z_f I_f/4p$ produce a magnetic field Φ_a, in the direction *bb*, whilst AT_c set up a crossfield Φ_c. These two fields, which have a phase-angle of more or less than 90 degrees, induce four electromotive forces across the brush terminals, two of them E_1 and E_1' by mere induction or transformer effect, two, viz., E_r and E_r' by rotation as in a direct-current armature (Fig. 15):

(1) E_r in the direction of Φ_a:

$$E_r = \frac{1}{\sqrt{2}}\, n_r \frac{Z_a}{a} \Phi_a\, .10^{-8} .\cos\beta = \frac{1}{\sqrt{2}}\, n_r\, Z_a'\, \Phi_a\, 10^{-8} \cos\beta$$

n_r = speed per second of armature, $Z_a' = \frac{Z_a}{a}$.

(2) $E_1 \perp \Phi_a$

$$E_1 = \frac{1}{\sqrt{2}}\, n\, Z_a'\, \Phi_a \sin\beta\, .10^{-8}.$$

n = periodicity of line voltage.

(3) E_r' in the direction of Φ_c

$$E_r' = \frac{1}{\sqrt{2}}\, n_r\, Z_a'\, \Phi_c \sin\beta\, .10^{-8}.$$

(4) $E_1' \perp \Phi_c$

$$E_1' = \frac{1}{\sqrt{2}}\, n\, Z_a'\, \Phi_c \cos\beta\, .10^{-8}.$$

All these E.M. forces are represented in their relative positions, in Fig. 14. In this diagram the following E.M. forces are also represented:

(5) E.M.F. of field winding $- E_f \perp \Phi_a = \Phi_f$ = field flux

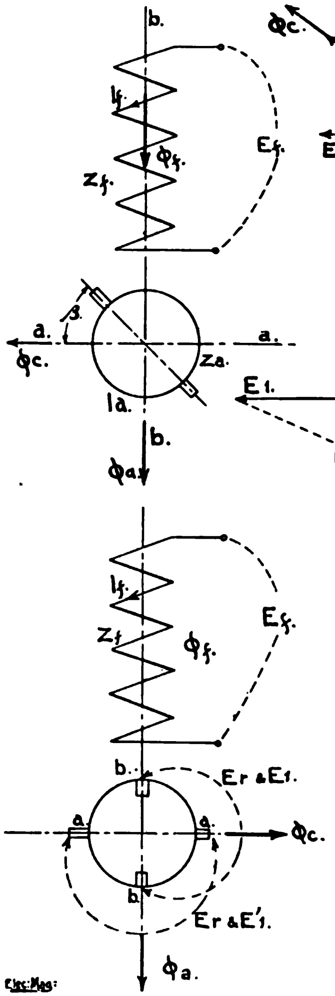
$$E_f = c.\, n\, Z_f\, \Phi_f\, .10^{-8}$$

c = voltage factor is 2, 2 for definite poles; 2, 1 to 1, 4 for distributed windings.

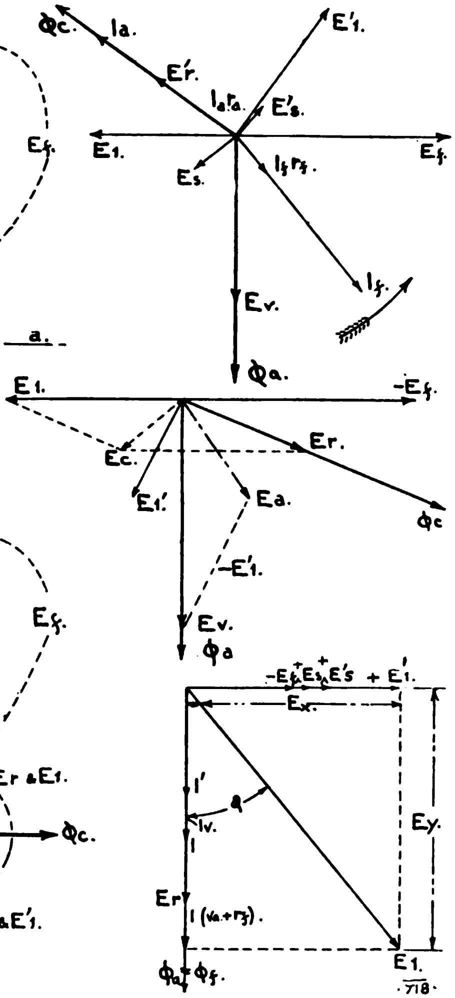
(6) The stray voltages corresponding to the strayfields: $E_s \perp I_f$ is the primary stray voltage and $E_s' \perp I_a$ the armature stray voltage, both depending upon the number and shape of slots.

(7) The ohmic voltage drops $I_a\, r_a$ (armature resistance) and $I_f\, r_f$ (field resistance) both in phase with the corresponding current.

In case the rotor has the shape of



FIGS. 13, 15.



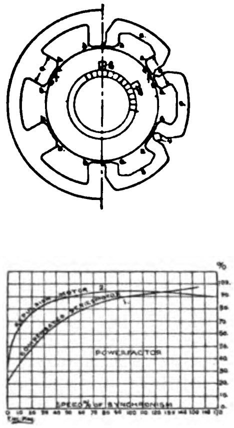
FIGS. 17, 16, 14.

the brush angle β being usually zero. Fig. 17 shows the diagram of the series motor: $I_a = I_f = I = I' + I_v$, I_v being $= \dfrac{\text{iron and friction losses}}{E_t}$ and I' the useful current. E_1 and $E_r' = o$. Add $E_r + I(r_a + r_f) = E_y$, and in the same way: $-E^f + E_s + E_s' + E_1' = E_x$. The terminal voltage is $E_t = \sqrt{E_x^2 + E_y^2}$, and the power factor $\cos\phi = \dfrac{E_y}{E_x}$.

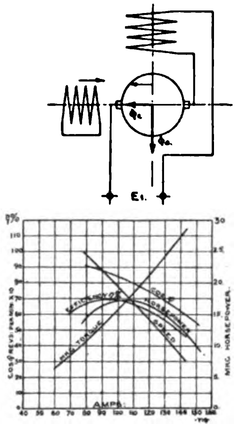
In order to get a high power factor, E_f, $E_s + E_s'$ and E_i' must be kept as small as possible and E_r must be large; an increase of $\cos\phi$ by the ohmic losses $I(r_a + r_f)$ means decreasing the efficiency. The stray voltages $E_s + E_s'$ are reduced by dividing the winding into many shallow slots and choosing short armatures. The cross E.M.F. E_1' is smallest for definite poles, especially if a small polar arc and split poles are used (Finzi, Fig. 18). The cross field may be even entirely neutralised by an auxiliary winding in the pole-shoes (Fig. 1) shifted against the main field winding by half a pole-pitch and either short-circuited (Fig. 19) or in series with the main current. As seen from the above formulæ the power factor becomes the higher the larger the ratio $E_r/E_t = \perp n_r Z_a' / n Z_f$, or as $n_r = n$ is equivalent with synchronous speed, this expression means in words: The series motor shows a good power factor, firstly, if it is designed with many armature and few field turns, which is identical with small airgap or low airgap induction, and secondly, if the motor runs with a high speed above synchronism, which mainly occurs for light loads. The normal speed of the series motor is usually chosen equal to nearly double synchronous speed, and the ratio armature

Fig. 15 with two brush-sets at right angles, the factors sin β and cos β have to be omitted in all equations for the E.M. forces. The resultant E.M.F. across the terminals *aa* becomes E_a (Fig. 17), which is the geometrical sum of $E_r = \frac{1}{\sqrt{2}} n_r Z_a' \Phi_a .10^{-8}$, and $E'_1 = \frac{1}{\sqrt{2}} n Z_a' \Phi_c .10^{-8}$. The resultant E_c across *bb* must be combined from $E_r' = \frac{1}{\sqrt{2}} n_r Z_a' \Phi_c .10^{-8}$, and $E_1 = \frac{1}{\sqrt{2}} n Z_a' \Phi_a .10^{-8}$.

For the *straight series motor* the general diagram may be very much simplified,



FIGS. 18, 20.



FIGS. 19, 21.

to field turns as high as 2 : 1 up to 5 : 1. At standstill the power factor is very low, 0, 3, and less, and approaches unity at very light loads and high speeds, as seen from Fig. 20, curve 1. As the field Φ_a, and therefore E_r and E_f, increase with growing current I and load, the speed n_r must be about inversely proportional to the current, the terminal voltage E_t = about $\sqrt{E_r^2 + E_f^2}$ remaining constant; therefore the alternate-current motor has the same speed characteristic as the direct-current series motor, the speed curve usually being steeper, however, as the iron inductions must be lower. Fig. 21 gives the working diagram of a 10 h.p. series motor of the Union Company, Berlin, provided with a compensating coil (25 cycles, 220 volts, airgap = 2 millimetres).

The *torque* of the single-phase series motor is

$$T_s = \frac{I' E_r}{\frac{2\pi n_r}{p} 9,81} = \frac{I' \frac{1}{\sqrt{2}} n_r Z_a' \Phi_a}{\frac{2\pi n_r}{p} 9,81} 10^{-8} =$$

$$1,15\, p\, Z_a'\, \Phi_a\, I'\, 10^{-6},$$

whilst the torque of the same direct-current motor becomes

$$T_d = \frac{I' E_r}{\frac{2\pi n_r}{p} 9,81} = \frac{I' n_r Z_a' \Phi_a .10^{-8}}{\frac{2\pi n_r}{p} 9,81} =$$

$$1,61\, p\, Z_a'\, \Phi_a\, I'\, 10^{-6}$$

that means for equal torque the single-phase motor must be larger than the direct-current or three-phase motor by about 30 per cent. From the formula for the torque it may be easily seen that the torque is approximately proportional to the square of the flux (I' being proportional to Φ_a) and also to the square of the terminal voltage E_t (Φ_t is proportional to E_t), which is not the case for the direct-current motor. Alternate-current motors are therefore very sensitive for voltage drop.

Whilst the torque of the direct-current or three-phase motor is constant for a given mechanical resistance, the torque of the single-phase motor just as its energy oscillates from a maximum T_{max} to zero at a periodicity equal to double that of the line. The mean torque T_m is

$$T_m = \frac{1}{\pi} T_{max} \int_0^{\pi} \sin^2 a\, d\, a = 0,\ 5\ T_{max}$$

This is a specially bad quality for railway motors on slippery tracks, as the wheels slip, when the useful torque T_m is only 50 per cent. of the maximum torque corresponding to adhesion or to the weight on an axle.

From Fig. 14 the exact vector diagram of the *repulsion motor* is developed in Fig. 22, based on these two conditions:

(1) The geometrical sum of the E.M. forces $E_r' + E_i + E_i' + E_r + E_s' + I_a r_a$ of the short-circuited rotor must be zero, if r_a includes the resistance of the brush connections.

(2) The counter AT = AT_g of the armature and the field AT = AT_f must have a resultant AT, which produces the main flux Φ_a, or, as already stated in the introduction to theory, the resultant of the armature current I_a and the field current I_f' must be equal to the magnetising current I_μ, neglecting, however,

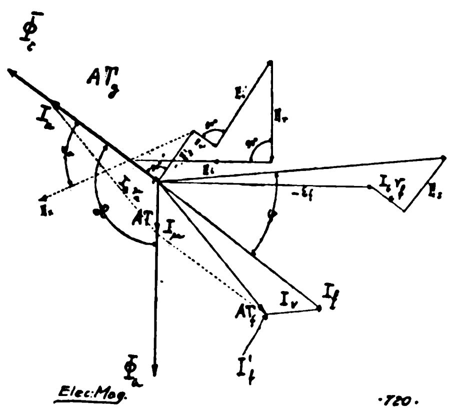


FIG. 22.

certain constants and supposing the armature current being $I_a \sin \beta$. The magnetising current I_μ is $= \frac{\Phi_a . R}{k' Z_f / 4p}$; R being the magnetic resistance of the field Φ_a and k'a constant. In order to find the whole primary current I_f the current $- I_\nu = \frac{\text{iron and friction losses}}{E_t}$ is added to I_f'. The terminal voltage E_t is the resultant of E_f, of the inductive drop E_s, and of the ohmic drop $I_f r_f$ in the primary winding.

The repulsion motor differs, therefore, essentially from the straight series motor, possessing an elliptical rotary field at all speeds consisting of the two fields Φ_a and Φ_c, which become equal and perpendicular to each other at synchronous speed (Fig. 23), forming a circular rotary field. The four main E.M. forces set up against two in the series motor influence also the size of the power factor, which is better at low speeds for the repulsion motor and reaches its maximum near synchronism, dropping then again (Fig. 20, curve 2). Whilst the series motor works best at double synchronism and higher speeds, necessitating a high number of poles and low frequencies, twenty-five and less, the repulsion motor works best at synchronism even for periodicities up

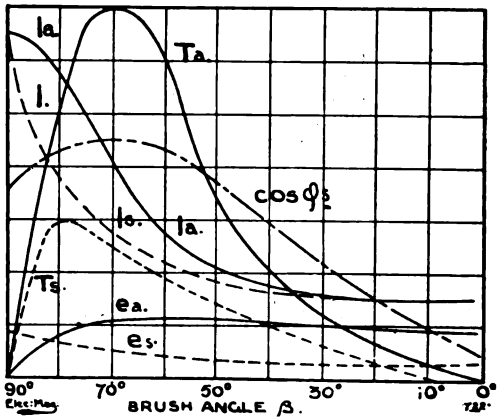


Fig. 24.

to fifty. The power factor of the repulsion motor, just as of the series motor, is raised by a large ratio of armature to field turns, by a small airgap, and by reducing the stray voltages. The ratio armature turns to field turns may be easily changed by varying the brush-angle β, the best power factor being usually reached for β = 75 to 55 degrees, as seen from Fig. 24, which represents the power factor cos ϕ_s, the current input I_s, the torque T_s and the E.M.F. e_s, in the short-circuited coil all for synchronous speed and variable brush-angle. T_a is the starting torque, I_a the starting current, and e_a the E.M.F. under the brushes at starting. Tests on the series motor represented by Fig. 22 arranged as repulsion motor gave the diagram Fig. 24 with a brush-angle β = 70 degrees.

The diagram of the *compensated motor*, Fig. 5, is represented in Fig. 25. It is supposed that two currents flow in the

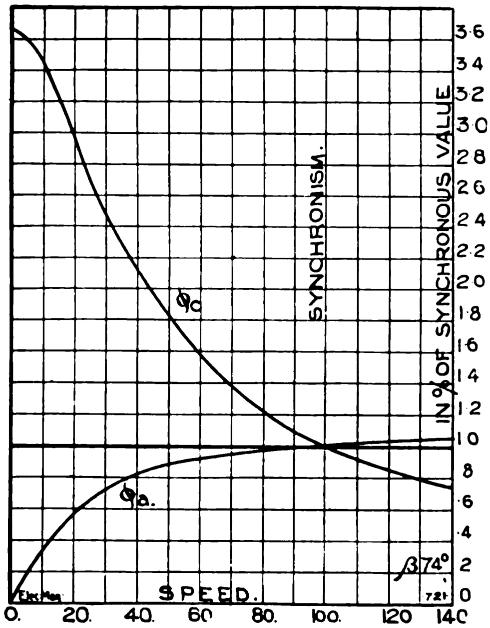


Fig. 23.

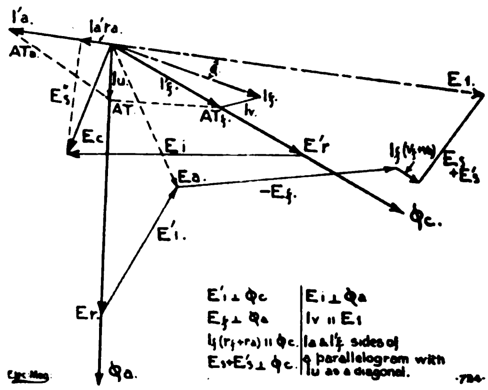


Fig. 25.

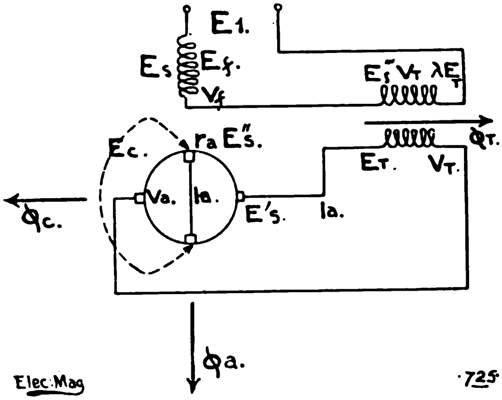


FIG. 26.

armature: I'_a through the short-circuited brushes *bb*, and the field current I_f through the brushes *aa*. The E.M.F. E_c resulting of E'_r and E_i produces the current I'_a, overcoming the inductive and ohmic drop E'_s and $I'_a r_a$ of the armature. The terminal voltage E_t is equal to the geometrical sum of the armature counter E.M.F. E_a resulting of E_r and E'_i + the E.M.F. of the field $E_f = cnZ_f\Phi_f.10^{-8}$ + the stray voltages E_s and E'_s in field and armature + ohmic drops $I_f r_f$ and $I_f r_a$ in field and armature. Armature current I'_a and field current I'_f gives as resultant the magnetising current Iu, which must overcome the magnetic resistance R of the field Φ_a. Iron and friction losses are taken into account as before by the

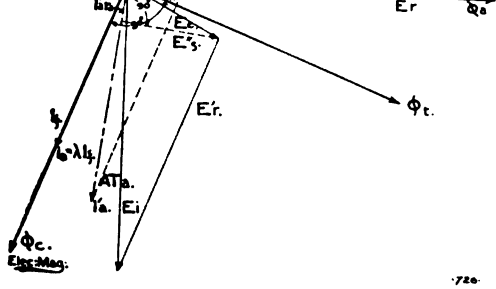


FIG. 27.

small current I_v, parallel to E_t. The working results of this motor are very similar to the repulsion motor, only somewhat more perfect, the power factor becoming unity near synchronism, whilst the repulsion motor does not surpass 0.90 to 0.95.

By adding a *series transformer* to the compensated motor one may vary the armature voltage E_a at will and the diagram takes the shape of Fig. 26. There are three circuits to be considered: the armature circuit E_c closed on itself, the armature circuit closed on the secondary winding of the transformer, and the field circuit. The flux of the transformer may be Φ_T, the secondary E.M.F. of the transformer be E_T, and the primary

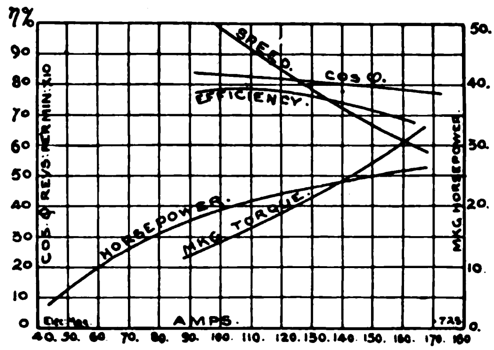


FIG. 28.

$\lambda\ E_T$, λ being the transforming ratio; the whole transformer stray voltage be E_s''', the secondary resistance of it r'_T, and the primary r_T. Now we have this condition for the armature circuit closed on the transformer (Fig. 27): $E_r + E'_i + E'_s + I_a\ (r_a + r'_T) = E_T$ (geometrically). For the primary circuit we get: $\lambda\ E_T + E_f + I_f(r_f + r_T) + E_s + E_s''' = E_t$ (terminal voltage) $I_a = \lambda\ I_f$. The resultant * of I'_a and I_f reduced to the same number of conductors is the magnetising current Iu of the motor necessary to produce the field Φ_a. I'_a is due to E_c, the resultant of E'_r and E_i, E_c being $= \sqrt{E_s''^2 + I_a'^2 r_a^2}$. The small magnetising current I′u of the series transformer is neglected.

Figs. 28, 29 represent the working diagrams of a compensated motor of the Union Company, Berlin, for 50 h.p., 6 poles, 800 revs. per min., and 40 cycles, designed

* More exact for the corresponding AT: The resultant of $\perp AT_a$ and $\neg AT_f$ is AT which produce the flux Φ_a.

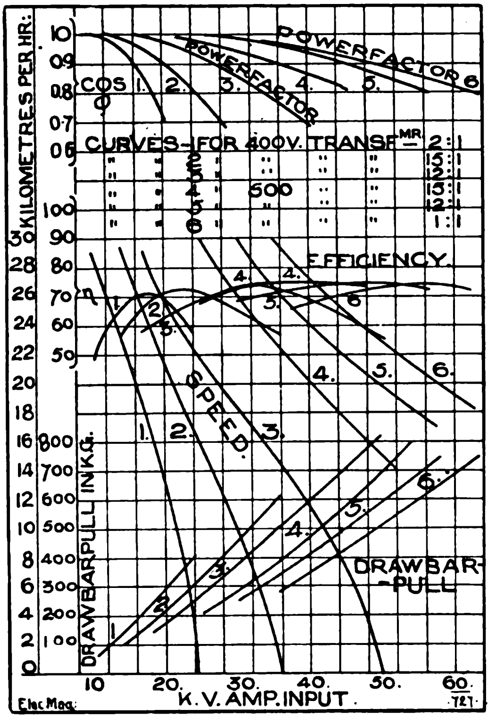


FIG. 29.

according to Fig. 6 with a variable ratio transformer.

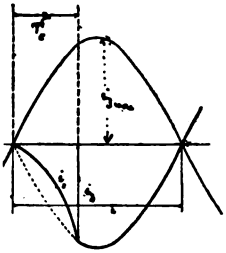
The formula for the *torque* as given for the series motor is not materially changed for the repulsion motor or the compensated motor. The general form of the formula for the torque of all commutator motors is $T = \Sigma C. I Z \Phi \sin a \cos \gamma = C_a. T Z \Phi_a \sin a_a \cos \gamma_a + C_c. T Z \Phi_c \sin a_c \cos \gamma_c$ T Z being the number of effective conductors, I the current, and Φ the flux, all in the *induced* part of the motor; a is the angle in space between the AT corresponding to I and the flux Φ; γ is the angle in time between I and Φ. The torque of the repulsion motor increases first with shifting the brushes from the neutral zone, reaching a maximum at about 70 degrees, decreasing afterwards. If for increasing speed the maximum torque of the repulsion motor is continuously desired, the brushes must be steadily shifted in the sense of rotation. For all motors the torque may be influenced by varying the terminal voltage or the armature voltage by main or series transformers.

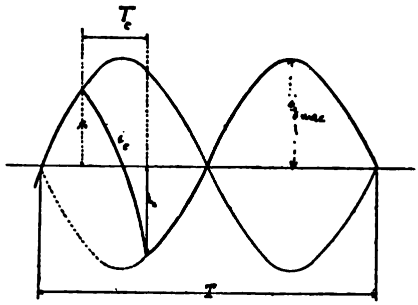
Commutation and Sparking: There are to be met the following difficulties in alternate current commutation in comparison with direct current:

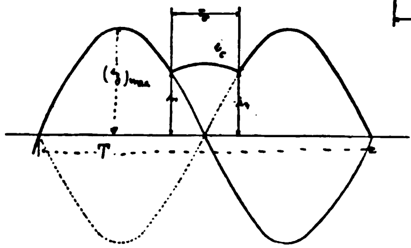
(1) The process of commutation is continuously varying as the commutation starts at various points of the alternate current. (Figs. 30 to 32). The difference $i_2 - i_1$ of the short-circuit current i_c at beginning and end of commutation varies between zero and about $2i_{zmax}$. $T = 1/n$ is the time of one period of the line current; $T_c = 1/2\, n_c$ is the time of commutation, n_c being about $v_c/2\, s_b$; v_c = speed of commutator, s_b = thickness of brushes.

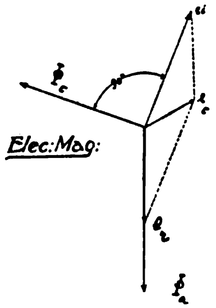
(2) Sparking in single-phase motors is due to the reactance voltage $e_R = L \frac{di_c}{dt} = 2\, n_c L(i_2 - i_1) = 4\, n_c L i_{zmax}$, just as for direct current, but besides that to an induced voltage $e_i = \frac{1}{\sqrt{2}}\, n\, Z_s\, \Phi .10^{-8}$, which is independent of speed, but is a mere transformer effect, t = time, L = coefficient of self-induction,* i_{zmax} = maximum current per armature circuit, Z_s = short-circuited conductors, Φ main field, either Φ_a or Φ_c. By rotation in an outside field Φ_s a third E.M.F. $e_r = \frac{1}{\sqrt{2}}\, n_r\, Z_s\, \Phi_s .10^{-8}$, may be induced in the short-circuited coil. The geometrical sum of these three E.M.F.'s produce the short-circuit current $i_c = \frac{e_R + e_i + e_r}{r_k}$. To keep this current and its energy which produces sparking within practical limits, there are three means: either all three E.M.F.'s are kept low or they neutralise each other, or the resistance r_k of the short-circuited coil is kept high. For the repulsion motor and the compensated motor e_i and e_r become equal and opposite for synchronism and both neutralise each other for synchronism and its neighbourhood (Φ_c being $= \Phi_a$, $\Phi \perp T n_r = n\, \Phi_c$, $\Phi_a = \Phi_c$), rendering commutation not more difficult than for direct current. As already stated, the pulsating fields are replaced by a rotary field for the repulsion motor at synchronism. For the series motor generally and for all other motors at starting and far below and above synchronism there remain only the two other expedients. The reactance voltage is kept low by using many commutator bars and multiple loop winding with

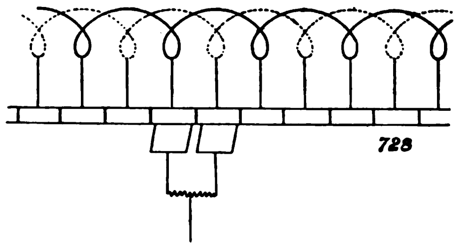
* Including the effect of mutual induction.











FIGS. 30 AND 33. FIG. 32. FIGS. 31 AND 34.

equaliser rings, a low voltage per commutator bar and across armature terminals (200 volts and less), short armatures, low speeds and small currents per circuit. The transformer effect is reduced (1) by taking as few short-circuited turns as possible (preferably one), which means many commutator bars and thin brushes covering few bars, for mechanical reasons brushes thinner than about 6 to 10 mm. however, cannot be used.

(2) By inserting high resistances into the armature coils, usually the commutator connections are made of nickeline and are sometimes partly imbedded into the bottom of the slots to increase their length and resistance.

(3) By making the main magnetic field Φ small, which is specially important when starting. The flux may be reduced by a transformer across the motor terminals, or better across the armature terminals only. If the iron is saturated to a high degree already at the normal current, a dangerous increase is impossible at starting. For the repulsion motor the field of the short-circuited coil may be made small by shifting the brushes by an angle β = 70 to 80 degrees near to the position of complete transformer action perpendicular to the neutral zone (Fig. 24 showing the induced voltage e_s and e_a under brushes); brush shifting must also be favourable to the series motor.

(4) By applying special schemes *f.i.* two independent sandwiched armature windings (Fig. 34) and splitting the narrow brushes into two insulated parts connected by a resistance; ; this type of winding has, however, never proved to be successful. A double auxiliary (horseshoe) electromagnet excited by the main current and opposite to the short-circuited coil may entirely compensate the main flux inside the said coil.

For the series motor it is desirable to avoid the distortion of the main field by the cross field for the same reasons as in

direct-current motors. As already stated, the cross field may be neutralised by a damping coil, or by specially shaped poles, or by high tooth and pole-shoe saturation. A too high reactance voltage may be compensated by auxiliary commutation poles excited by the main current. This commutation field may also be deviated from the main field by special forms of the pole-shoes or by brush shifting.

The Oelikon Company has built a 200-h.p. motor with auxiliary commutation poles, and the General Electric Company, New York, neutralises the reactance voltage by a distributed winding similar to Ryan's and Déri's schemes for direct-current machinery.

When direct-current series motors are suddenly interrupted at light loads and high speeds and quickly inserted again without using the rheostat, a phenomena may occur called "flash over" between adjacent brush sets produced by the current rush and the magnetic inertia. This flash over seems to be less probable for single-phase commutators on account of the damping effect of self-induction and on account of the laminated field body which accelerates the setting up of magnetic fluxes. For repulsion motors which have no potential difference at all across the brushes a flash over seems next to impossible. If a single-phase commutator motor is braked down to standstill against a heavy overload, the short-circuited coil under the brushes is liable to burn out, which is less to be feared when the motor is running, as the coil changes then continuously. The commutation problem is the most serious drawback of the *single-phase* commutator motor; the multiphase commutator offers, however, no commutation troubles at all, being a mere frequency changer and working with rotary, not with alternating fields at all speeds.

The *power factor* of all commutator motors at starting is very low, less than 30 per cent., though the current for a given torque is less at starting than for running at normal speed by 20 to 50 per cent. The power factor for normal speed is about the same for the series and repulsion motor, 90 to 95 per cent. for usual cases, whilst the compensated motor may reach unity for synchronism or for several speeds by inserting a variable ratio transformer into the armature circuit. At light loads the power factor is better for the series motor, and at overloads the repulsion motor shows better results. The power factor of all commutator motors is favourably influenced by a high ratio of armature turns to field turns, by a small airgap and low airgap and iron induction, by small leakage in the primary and secondary winding, and by using small periodicities (twenty-five and less). Besides that the series motor must run as much above synchronism as possible, and its cross field must be compensated. For the repulsion motor the brush-angle β is of great influence, as it varies the ratio armature to field turns. For a brush-angle of 90 degrees against the neutral zone the power factor is small (Fig. 24); it increases for decreasing angle β, reaches its maximum for about 80 to 60 degrees, slowly dropping again to small values.

F. Niethammer

(*To be concluded.*)

LONDON POST OFFICE TELEPHONE SYSTEM.

By W. NOBLE, A.I.E.E.

(Concluded from page 246.)

DISTRIBUTING JOINTS.—A distributing joint is a simple arrangement for the subdivision of seven-pair cables, so as to serve a single subscriber or a building containing but a few subscribers. It is made in any combination of seven-pairs, some of the most useful sub-divisions being as follows:

Four pairs and three pairs;
Four pairs, two pairs, and one pair;
Three pairs, three pairs, and one pair;
Seven single pairs.

Three-pair and four-pair cables are further sub-divided into three and four single pairs respectively. The combination most largely used is that of seven single pairs. It consists of six pieces of single-pair cables, about fourteen inches long, grouped round a central pair as illustrated in Fig. 24. The component pairs are bound together and at a distance of four inches from one end an inch of the group of pairs is placed in a circular mould, into which molten lead is run. The seven single-pair cables are thus combined by means of a solid plug of lead.

To some extent the tenacity of the sheathing lead is reduced where the molten lead is applied, and as the cables are subject to a certain amount of bending, the solid plug is cast with a projection at each extremity as a precaution against damage. The longer or outside ends of the grouped pairs being subject to the greater amount of bending, the projection towards them is larger. As a further precaution against damage, the small cables are served with prepared tape, bound over their end of the solid plug. And as the seven-pair cable at its junction with the lead-sleeve that covers the joint (*see* Fig. 24) is also subjected to a certain amount of bending, the joint is protected by a tapered lead thimble. A distributing joint is connected to a seven-pair cable by the four-inch lengths of the small cables. The process of jointing is as follows: A thimble followed by a lead-sleeve is passed over the end of the cable. The ends of the single-pair cables and about four inches of the seven-pair cables are stripped of their lead and the conductors jointed in the ordinary manner. The lead-sleeve is drawn over the joint on to the solid plug, slightly "choked" at each end by special pliers and soldered by the aid of a blow-lamp. The thimble is next brought forward on the sleeve, to which it is then soldered at one point.

The joints are tested by dry air forced in at a screwed inlet provided in every sleeve, and if all is satisfactory the cap is tightly screwed on. If there be danger of the cap working loose a tinned-copper disc is soldered over the inlet as an additional safeguard. The free ends of the single-pair cables are then ready for use. For any intermediate points where the whole seven pairs are not required, *double* distributing joints are supplied. Fig. 25, which shows the complete route of a subscriber's line. illustrates the use of the

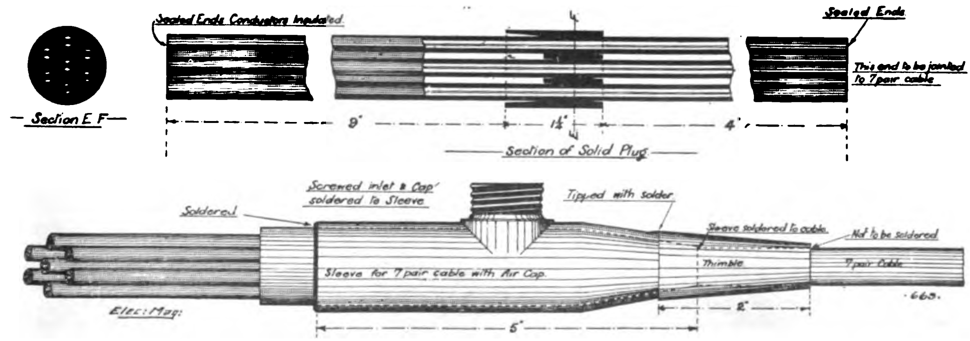


FIG. 24. SEVEN-PAIR CABLE DISTRIBUTING JOINT

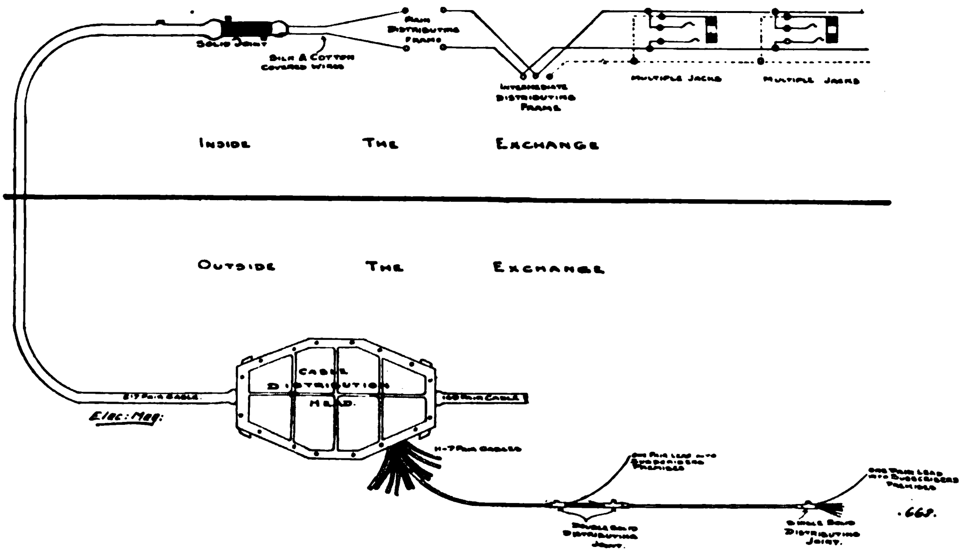


FIG. 25. DIAGRAM OF SUBSCRIBERS' COMPLETE LINE.

single and double distributing joints. Between the place where a double distributing joint is fixed and where there is a single one, there are spare wires, but with the growth of the telephone system the double distributing joint will be cut out, the existing cable joined through direct to the more distant point, and a new seven-pair cable run to the nearer point. The utility of the double distributing joint is that it avoids the necessity for running a large number of cables at the outset.

Coding of Cables.—Each cable is known by a distinctive code. Junction cables have four-letter codes, subscribers' main cables three-letters; and distribution cables one-letter followed by the code of the main cable of which it is a branch. Fixed on each cable is a lead label in bracelet form stamped with the code.

Numbering of Wires.—All wires in a cable are numbered, and wherever they are exposed in a cable head or a test frame a manilla label is attached to each wire. The upper end of the label is coloured, a different colour being borne by each group of fifty pairs for the purpose of facilitating the finding of a wire. The lower end is left blank for the reception of the number. Labels, as well as paper-sleeves, are dried before use.

Leading-in.—The cable connecting a footway box with a building is invariably paper-core lead-sheathed, and is generally carried in a one-inch, one and a half-inch, or two-inch pipe, the size depending upon the number of probable subscribers; but into the largest buildings, containing many suites of offices, a main cable is carried in a three-inch cast-iron pipe. When the number of subscribers in a building is small, a single-pair cable is taken in as required; where there are likely to be seven subscribers, a seven-pair cable is carried into the building and a distributing joint fixed in the most convenient place; and where, again, there is a probability of a larger number of subscribers, a main cable is carried into the basement of a building and terminated on a special distributing-frame, from which any required size of cable can be taken. In many large buildings in Central London the post office installed at the outset a complete system of casing in order that a subscriber in any part of the premises might be at once served.

Leads.—The leads for indoor work are of the indiarubber and cotton-covered class, and of three types: the first, without further protection, used in wood-casing or wrought-iron tubing; the second, protected with braiding (in different colours), used inside rooms where there is no casing; the third, protected by lead sheathing, used without casing except where there is liability to mechanical injury.

Cable Bearers in Manholes.—The distance between the conduits opening into each

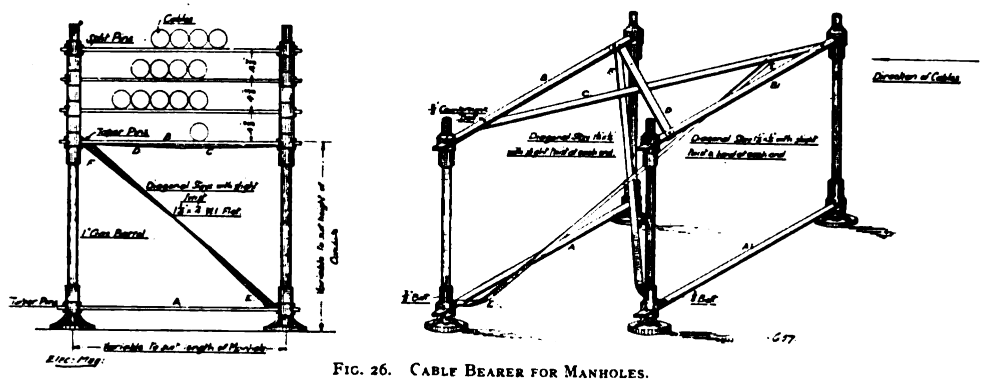


FIG. 26. CABLE BEARER FOR MANHOLES.

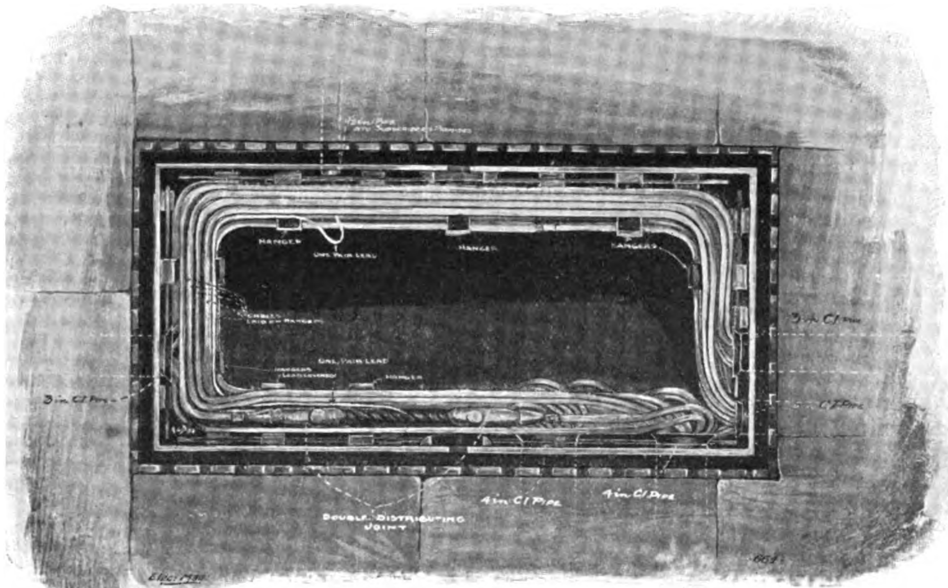


FIG. 27. PLAN OF CABLE SUPPORTS FOR JOINT-BOXES.

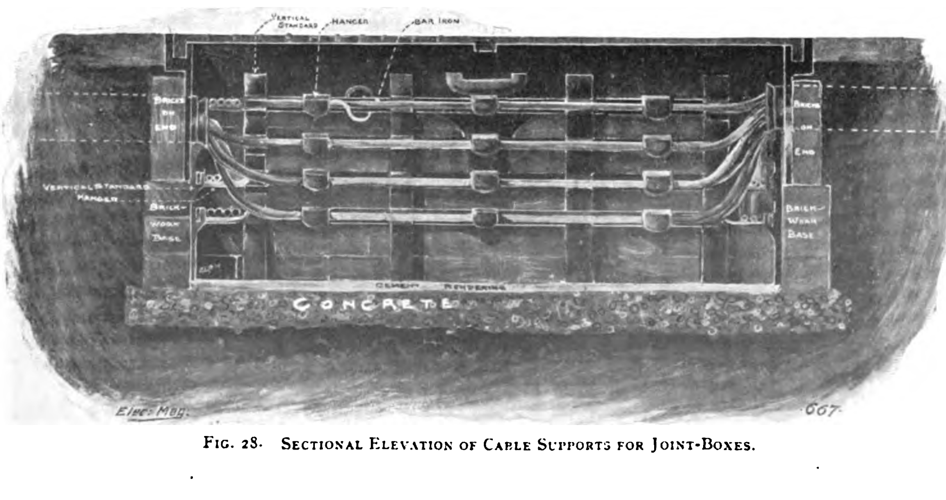


FIG. 28. SECTIONAL ELEVATION OF CABLE SUPPORTS FOR JOINT-BOXES.

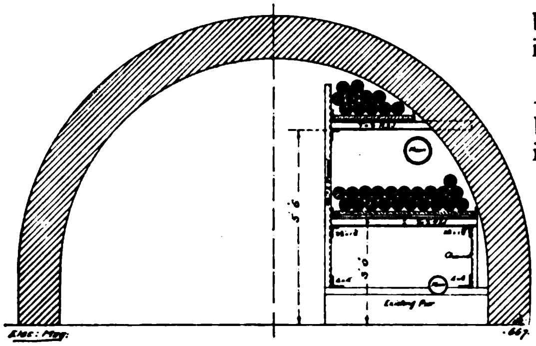


FIG. 29. CABLE BEARERS IN SUBWAYS.

side of a manhole being too great for the cables to be self-supporting, cable-bearers are provided, built up as required. Fig. 26 illustrates the type of bearer used. The lower portion of the bearers is erected before the jointing of cables is commenced. the first set of flat bar-supports being fixed level with the lowest tier of conduits. That part of a bar upon which a cable rests is covered with lead, which forms a cushion for the sheath. To save space in a manhole the bearers are kept as narrow as possible.

Cable Supports for Joint-boxes.—The successful employment of small lead-covered cables depends largely on the care with which they are handled and their consequent immunity from bends. In each footway box they are, therefore, placed on supports. A typical box and the method of supporting the cables are shown in Figs. 27 and 28.

Subways.—The post office has, as far as possible, availed itself of the existing subways, and has erected therein cable-bearers of various capacities. Fig. 29 illustrates a form of bearer in common use.

Gun-metal Linings for Seven-pair Cables.—In the description of the cable distribution heads by an inadvertence a drawing illustrating the seven-pair lining, including the "bored wooden disc" referred to in the first paragraph on page 247, was omitted. Fig. 30 supplies the omission. In that figure the internal and external fittings of the lining are shown. Inside the head are a slotted gun-metal nut and a brass washer; and on the outside a dressed leather washer and the gun-metal lining, this latter having a recess to take the bored wooden disc.

The linings for all sizes of cable distribution heads are interchangeable when they fit into the head, but linings of different sizes are manufactured to suit the various sizes of cable.

The following are some of the standard sizes:

Gun-metal Linings for Cable Distribution Heads.

20 lb. Conductors. No. of Pairs.	Cable: External Diameter. Inches.	Lining: Internal Diameter. Inches.
217	2.65	2.687
192	2.60	2.687
169	2.45	2.687
147	2.35	2.687
127	2.20	2.687
108	2.10	2.25
91	1.90	2.00
75	1.85	2.00
61	1.65	1.687
48	1.55	1.687
11.7-pair cables	—	4.5

Fitted linings containing small cables, other than seven-pair cables, are prepared to meet special requirements.

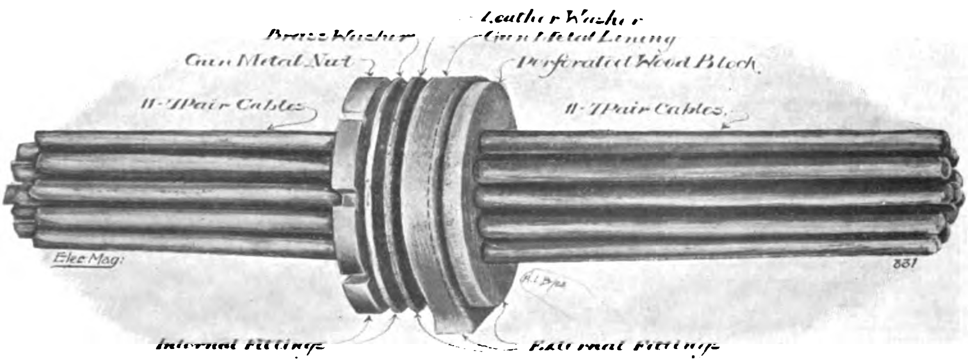


FIG. 30. GUN-METAL LININGS FOR SEVEN-PAIR CABLES.

POWER: and its application to INDUSTRY

Readers are referred to the World's Electrical Literature Section at the end of the Magazine for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

Power in Bulk for North London.

By the ASSOCIATE EDITOR.

In our last issue we referred to the tramway system recently inaugurated in North London giving a map of the chief routes in the Traction Section. We are now pleased to be able to furnish some details of the power source whence these tramways are operated, and through the courtesy of the North Metropolitan Electric Supply Co. to reproduce photographs of the plant and power house. The latter illustrated in Fig. 1 is of brick and steel work, with temporary end for extensions, though the present space will accommodate considerable additions to the plant now in operation. The adjoining River Lea acts as a highway for coal and a source for condensing water, a private dock having been built for the purpose. Electric coal handling plant ensures the efficient transport of fuel; while the ashes are similarly dealt with, being subsequently discharged into a hopper and thence carted away. Extra storage capacity has been needed to "tide over" spells of wet when the canal rises and stops barge traffic. Six Babcock and Wilcox boilers are installed each fitted with the same company's chain grate stoker (The Elec. Mag., vol. ii., No. 1, p. 87) and internal superheaters, and capable of evaporating 15,000 lbs. of water per hour. Surface condensing plants by Mirlees Watson, with electrically driven accessories, have been installed. The generating sets correspond with the latest practice, and comprise high powered steam turbines direct coupled to their respective generators. At present three 1,000 k.w. sets are installed, the turbines by C. A. Parsons and Co., and the alternators by Brown Boveri and Co. (of Baden). The latter generate three-phase current at 10,000–11,000 volts pressure, this being the highest used in this country for traction work (Fig. 2). Exciting current is furnished by four Belliss B.T.H. sets, two of 100 k.w., and two of 150 k.w. output, a storage battery of 63 Pollak cells being used in conjunction. The H.T. board is of the latest remote control type and calls for little detailed remark. Four sub-stations have at present been erected at Edmonton, Wood Green, Finchley, and Hendon. All except the

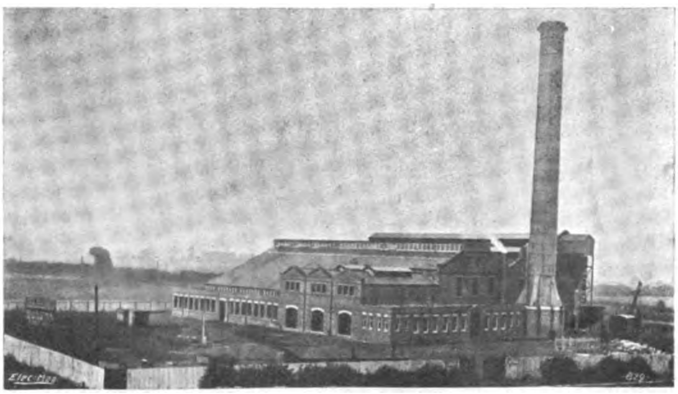


Fig. 1. Exterior of Brimsdown Power House.

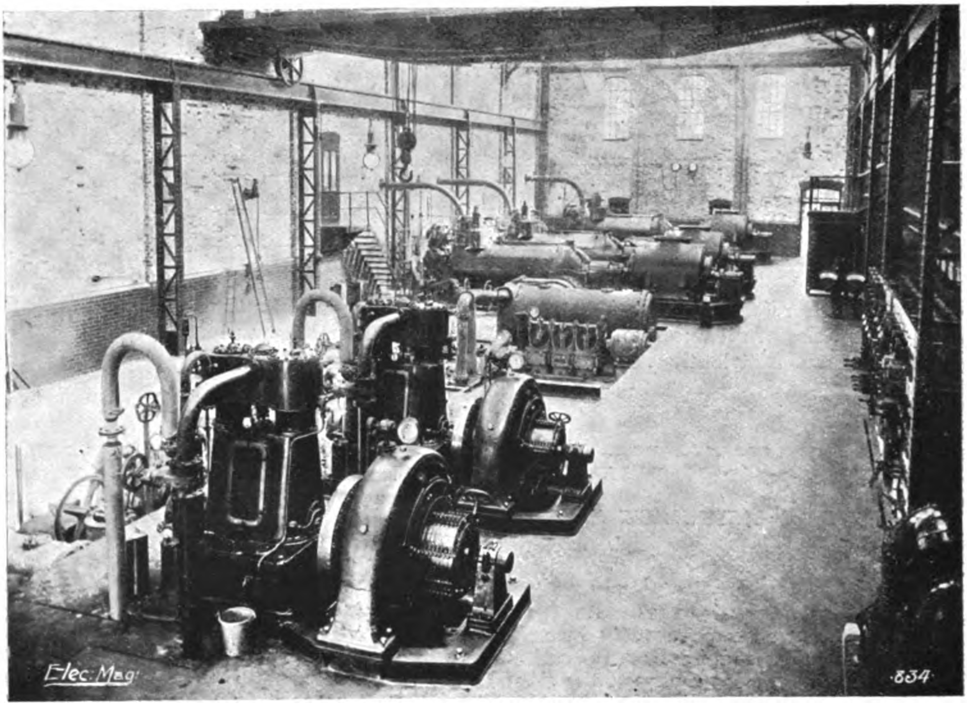


FIG. 2. ENGINE-ROOM, BRIMSDOWN POWER HOUSE.

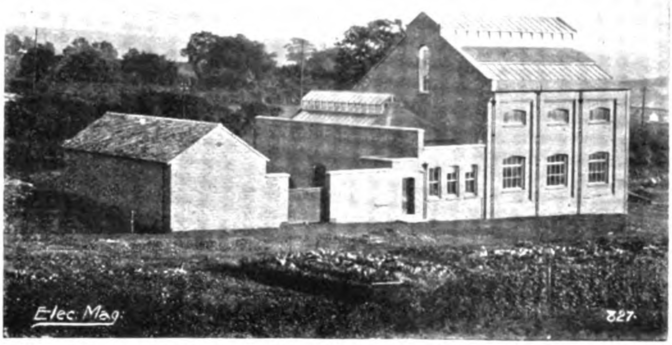
latter which is fed from Willesden, are supplied from Brimsdown, and underground cables of British Insulated and Helsby make are used. The entire sub-station plant except cranes, is by the B.T.H. Co. Rotary converters of the usual type are installed, a small induction motor being used for starting. Suitable A.C. and D.C. switch gear has been fitted in each case, the former being placed in a separate room, and operated by rods from a board in the sub-station. Oil cooled transformers of 92 k.w. capacity each lower the line voltage for operating the rotaries. These transformers are located behind the switchroom and are single phase delta connected. With each set of three an induction regulator is provided. The sub-stations are all in telephonic communication, as well as being connected to section pillar boxes. The Finchley station is not yet completed. and Edmonton is smaller than Wood Green. The Brush Electrical Engineering Co. were the general contractors for the power-house work, and the firms mentioned, sub-contractors.

In a subsequent issue we shall give some particulars of the company's other large station at Willesden. Our readers will remember that this was taken over from the Willesden Council who originally erected it for their own district.

A Small Gas-Driven Power-Plant.

IN our last issue we made reference in this section to the work of gas-engine makers and their apparent dilatoriness in opening a field for the large gas-engine as a vital competitor to steam. We have since received particulars of a small plant which has been installed to furnish the Leek district with electric light and power. It is in such small areas as this that the gas-engine maker can find a field for his products, seeing that he is either willing or constrained to manufacture only in small sizes. We wish the undertaking a greater measure of success than has been meted out to some of its predecessors, and shall watch its records with the greatest interest. With the history of the undertaking we have little or nothing to do; we find that it is marked with the usual indecision as to whether the Provisional Order be worked by the Council or not, and after numerous delays consultants were appointed and gas-plant decided upon. The buildings accommodate gas-engines and dynamos, balancers and motor generators, also a battery of accumulators. There are two 60-kw. 500-volt generators driven through flexible couplings by two horizontal gas-

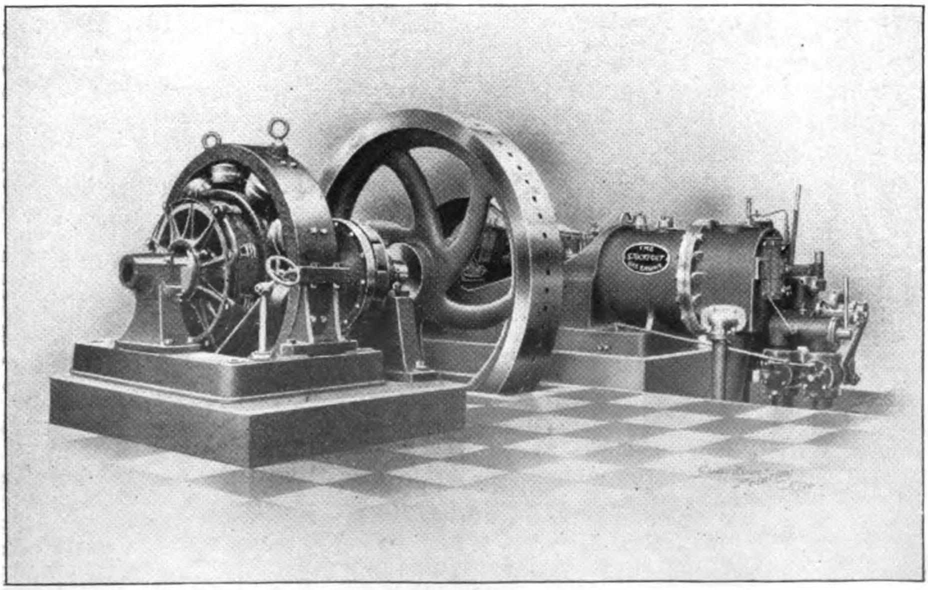
engines, each of 100 h.p. The engines are regulated to govern within 2 per cent. of normal speed between no load and full load, and extra heavy fly-wheels are fitted in addition. The ignition is electrical and in duplicate. The adjoining illustrations will give some idea of the arrangement of the plant. Gas is furnished by a 6-in. main, from the Council's own gas-works, a governor being fitted at the works. The engines are the "Stockport" type by J. E. Andrew and Co., Reddish, and the electrical plant, dynamos, and balancers by the Industrial Engineering Co., Hyde, Messrs. Burstall and Monkhouse being the consulting engineers. The installation serves to illustrate what can be done with direct-connected gas units, though on a comparatively small scale. It will be an addition to the few public gas-driven plants in this country, and its records should be watched closely and compared with stations of similar output driven by steam. We are indebted to the contractors mentioned for the loan of photos and use of blocks illustrating this short article. As opportunity affords we shall refer to further interesting gas-driven plants, drawing comparisons between them and those driven by steam.



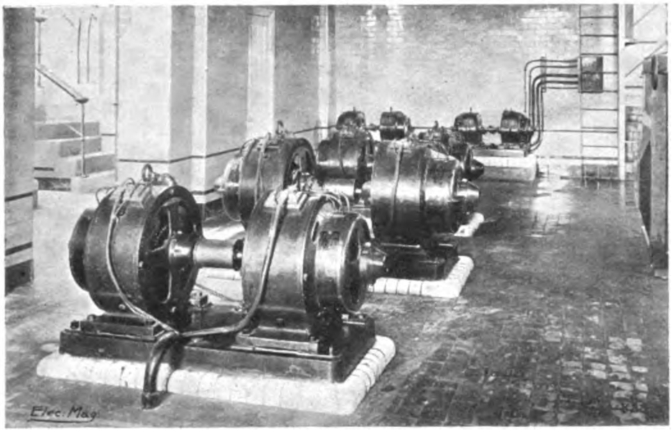
Exterior, Leek Electricity Works.

THE ELECTRICAL EQUIPMENT OF THE KARAWANKEN TUNNEL.

A most interesting electrical power transmission plant has been utilised in Austria-Hungary for the construction of the Karawanken Tunnel which is worthy of consideration. Electric power has been used for operating boring machines, ventilating plants, and locomotives (*see* "Traction section this month"), as well as other machinery in the construction of the Wocheimer Tunnel, which is 3¾ miles long, as well as in the construction of the Karawanken Tunnel, which is 4¾ miles long. These tunnels are on railways which connect



100-h.p. Gas-Engine and Dynamo, Leek Power Station



BALANCER ROOM, LEEK ELECTRICITY WORKS.

the city of Trieste with important cities and towns in Austria-Hungary.

The Karawanken Tunnel begins at Rosenbachthal, South Velden, on the Worthersee. The south end of the tunnel is located at Birnbaum on the Staatsbahnlinie Tarvis-Laibach in the valley of Wurzener Save. The construction of the tunnel was started at both ends, meeting in the centre at a height of 2,000 ft. above the sea-level. The fall to the south was 6 per cent., while the grade to the north was 3 per cent.

As there was no water-power available in the neighbourhood of the tunnel entrances, it was necessary to instal a power transmission plant at Rothweinbach, six miles from the south portal, and another at Rosenbach, a distance of 1½ miles from the northern portal. The water-power available at Rothweinbach was equivalent to 900 h.p., and the power house was equipped with three turbines, each of 450 h.p. and each coupled to 400-k.w. three-phase alternators, running at 750 revs. per min. These machines supplied current at a frequency of 50 periods and a pressure of 5,500 volts. The switchboard consists of three marble panels for the measuring instruments, regulating apparatus, and switches, connected with the high-tension three-phase power transmission line, which connects the power house with the tunnel entrance, highly insulated iron-armoured cables being used within the tunnel. The construction of this power house was extremely difficult on account of the trouble of transporting the building material and machines to the site of the plant, and a new bridge had to be constructed for aiding in the work of transportation. The total length of the high-tension line is about six miles, including a section of underground armoured cable.

The ventilator plant consists of two groups with three centrifugal ventilators, each group of three being directly coupled to a 180-h.p. alternate - current motor. The Rothweinbach central power station also supplies current for operating two electrically driven compressors, each requiring 200 h.p., as well as a workshop in the same building, the total power used being 438 h.p. The power station on the north side of the Karawanken Tunnel, located at Rosenbach, uses the waters of the Drau River. This plant is supplied with three turbines of 300 h.p. each, operating at 500 revolutions per minute and direct-coupled to a 270-kw. three-phase generator. This station is connected by high-tension transmission lines, 1½ miles long, to the ventilator plant at the north tunnel-entrance. This line consists of three bare copper wires mounted on insulators on wooden poles. The plant includes two three-phase 180-h.p. motors directly coupled to two groups of three ventilators, similar to those at the south side of the tunnel.

A most interesting feature connected with the construction of the Karawanken Tunnel by the aid of electric power is the use of electric boring machines. These are equipped with four motors of 43 h.p. The 5,000-volt three-phase current is conducted through a three-conductor iron-armoured high-tension cable to a 25-k.w. transformer to lower the pressure to 250 volts. The low-pressure cables are also iron-armoured and lead-covered, with three conductors. These boring machines now in operation at the north side of this tunnel excavated during April, May, and June 1904, 192 yards, 168 yards, and 180 yards respectively, while for January, February, and March 1904, 182 yards, 160 yards, and 210 yards respectively were excavated, the size of the tunnel being 8 ft. and 6.8 ft. in cross-section.

POWER PAPERS BEFORE THE CONGRESS.

It was only natural that the views of engineers representing widely different standards of practice in power transmission lines should be expressed before the International Electrical Congress. Section D was allotted to power transmission schemes in general, and American and Swiss practice were freely discussed. Dr. Perrine has had long association with Pacific Coast schemes and has become an authority in power transmission of late years, and in his remarks on American practice he said that 1,000 volts

per mile might well be allowed, up to sixty miles, as beyond 60,000 volts present practice had not yet gone. Where direct generation at 6,000 or 12,000 volts was not practised, the tendency was to generate at 2,300 volts. The horizontal oil switch would he thought come into favour, and for line-conduction materials the choice rested between aluminium and copper. A satisfactory lightning-arrester for pressures above 25,000 volts was needed. Mr. F. G. Baum, also of Californian practice, dealt with the control of high-potential long-distance lines, and among other things referred to the insulators chiefly used on 50,000-volt lines in California. Steel towers were considered the ideal line-supports, but so far few had been used. Conductors for long spans were the subject of Mr. F. O. Blackwell's paper, and Messrs. Kelly and Bunker offered particulars as to the mitigation of high-tension transmission difficulties. Pressures above 30,000 volts were considered, and lines above fifty miles in length. Metal insulator-pins were recommended, and poles should be periodically treated to prevent decay. Every second or third season the pole should be treated 18 in. below ground by digging away the earth for the purpose. The cost of this varied from 60 cents to $1 per pole. Mr. Gerry, in his paper on the construction and insulation of high-tension lines, dealt exclusively with American practice, quoting work already done and the chief points of a successful commercial undertaking. The construction of steel towers was entered into fully. Mr. Hancock outlined the characteristic features of the Bay Counties line in California, a system in which a 232-mile line between the Sierras and San Francisco is included. The operation of many power-plants in parallel is a very interesting problem, and Mr. R. F. Hayward, after considering the operating features of some 500 miles of line in Utah, dealt with the parallel operation of a string of power-plants from the Atlantic to the Pacific, a combination which might furnish power to every railway and town *en route*, with little or no fear of breakdown. In our next issue we shall deal more fully with the more important papers, but would refer our readers to the World's Electrical Literature Section at the end of the Magazine for the full list of papers presented.

A 40,000-VOLT EUROPEAN PLANT.

On July 11 last the first 40,000-volt plant installed on the Continent was put into operation, this pressure being the highest yet attained in Europe. The contractors, Messrs. Brown, Boveri and Co., are to be congratulated on the success of what may perhaps be regarded as a daring experiment. The pressure has been adopted, not on account of the length of the line, but to transmit the maximum of power with a minimum of loss. The line is nearly twenty miles long, and will ultimately furnish 4,000 h.p. to some important cotton mills in Milan. The Serio River supplies the requisite water-power for three 1,000-h.p. turbines (Escher-Wyss), each driving a 850-k.w. Brown Boveri alternator. Each machine is coupled direct to the primary of a 850-k.w. transformer, without intervening switchgear. All the switching is done on the 40,000-volt side of the transformers, standard gear being adapted for the purpose. Generation is at 4,000 volts. The transformers are oil insulated and water-cooled, and the high-tension coils are arranged in sections to avoid breakdown. We shall hope to make reference to the switchgear in a subsequent issue. Special insulators are used for the line, these having been made for the scheme, and are tested at 80,000 volts before use. Wooden poles and cross arms support the line, the longest span being 390 ft. The receiving station is at Nembro, where two 500-k.w. transformers, similar to those at the power house, are used to lower the line voltage to 500 volts. An isolating switch on the line is provided outside the station for emergency purposes. The plant has been operating since its opening with complete satisfaction, and the results have far exceeded expectations; the line withstanding the severe thunderstorms of this last summer. Our contemporary, *The Electrical Review*, recently published a long illustrated account of the installation.

STATISTICS OF FRENCH CENTRAL STATIONS.

L'Industrie Electrique has recently published an enumeration of all the electrical installations in actual operation in France. From these, we gather that the electrical industry is making steady progress in that country, especially as regards the erection of large power stations: for whereas formerly each locality had its own private plant, there is a growing tendency to centralise the production of energy necessary for several isolated installations in one large station, the result being a better load factor, improved working conditions, and a general lowering of tariffs. Further, it has thus become possible for small thinly populated centres, for which an independent plant would have been out of the question, to derive their electricity from one common distributing system. The electric motor is gaining ground everywhere, at Lyons, St. Étienne, and Grenoble for instance, it is extensively used in workmen's homes for driving weaving looms and other machinery. It has even penetrated into modern farms, where it is superseding

the locomobile: witness the installations at Agincourt and Séchelles and several others. Amongst large distributing systems, the most important is undoubtedly that of the "Sté. Méridionale d'Electricité," whose lines have a total length of nearly 370 miles, completely covering one department (Aude), and extending into several others. The energy for this system is transmitted from the power house at St. George's at a pressure of 20,000 volts. Examples of high-tension plants are also to be found in the Isère, at Grenoble, Voiron, Rives, Vienne, &c., where pressures have been adopted of 25,000, 33,000, and even 36,000 volts. A noteworthy feature in continuous-current installations is that working pressures of 220 volts have not been brought into extensive use—in fact, the 220-volt incandescent lamp has found but little favour, one reason for this being probably that the adoption of alternate current is becoming more and more general. Another point is that the frequency of alternate current, a very variable quantity in old installations, has now settled down to a fixed value of 50 cycles per second, by a common understanding for which manufacturers should be congratulated.

GENERAL POWER NOTES.

Power in Hotel Astor, New York.

THE Hotel Astor recently completed in New York at a cost of nearly two millions has 1 000 k.w. of plant in four 250 k.w. sets for its lighting and power installation. Almost everything possible has been driven by electric motors, a speciality being made of electric dumb waiters. The units are slow-speed machines driven by horizontal engines, and a battery is used in reserve. The engine-room can be viewed from an observation gallery by the guests in the hotel.

An Important Californian Company.

THE Northern California Power Company has recently taken over the control of several minor electric power concerns, and consolidated an extensive transmission system once served by several stations. The total length of line now operated is 228 miles supplied from the stations totalling 5,250 k.w. capacity. The first of these at Volta using the waters of Battle Creek contains three 750-k.w. generators operated from Pelton wheels. The water-supply is curious in that it traverses several "ditches," two creeks, and a lake before reaching the pipe line. The latter of steel for 6,000 ft., has a section of 800 ft. of wooden pipe built up of redwood staves. The catchment area is so extensive that water for full-load operation can always be relied upon. The second power house known as the Kilarc takes its water from Cow Creek, a branch of the Sacrimento River. The waterway is nearly four miles long, and its watershed, with an area of twenty-six square miles, is 3,800 to 5,000 ft. above sea-level. Two Pelton wheels of 1,500 h.p. output and fitted with Lombard governors drive two 1,000-k.w. generators, the 2,000-volt current being stepped up to 35,000 volts by oil insulated water-cooled transformers, a special draining system having been introduced. The trunk line coupling Kilarc with Volta has not yet been erected, so that both plants are at present operating independently.

Power from the Rhine.

AN electric company is studying the construction of a canal to cut the curve formed by the Rhine at Laufenburg, by means of which some 30,000 h.p. could be obtained at the junction with the river, owing to differences of level. A plant of this magnitude would materially assist industry in these parts, both on the Swiss and German sides of the river. The necessary powers have been granted by the Swiss Government, and after much discussion the Grand Duchy of Baden has just followed suit.

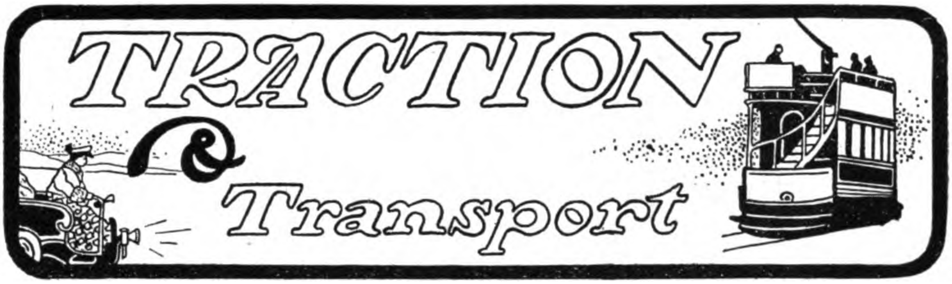
Roumanian Progress.

MARKED progress continues in the development of the electrical industry in Roumania. Amongst the central stations recently erected, two are specially worthy of note, *i.e.*, those of Bucharest and Braila. The first is not quite completed; but the second is in full activity, supplying continuous current to a tramline 14½ miles long, and a lighting system. The rolling-stock on the line comprises twenty motor coaches and four trailers. There are at the central station three Helios dynamos of 200 h.p. each, direct coupled to compound vertical steam-engines, special means being provided for shifting the revolving field parallel to the axis when it is necessary to inspect the armature.

Compressed Air for Electrical Lifting Apparatus.

THE use of electric brakes in hoisting is open to the objection that whether they are connected in series or in parallel, their action is not sufficiently powerful and sudden to stop the motor directly they are applied. M. Jordan has just invented a system in which compressed air is used to increase the power of an electrically driven hoisting apparatus. The brake comes into action the moment the piston of a brake-cylinder communicating with a compressed-air reservoir is driven forward under air-pressure. An electro-magnet actuates a device which brings the cylinder in communication with the reservoir or the atmosphere, the brake being on in the first case and off in the second. This electro-magnet is itself operated by the motor-starting device, but a small switch can sever this connection. One of the advantages of this system is that the electro-magnet is of very small dimensions, as instead of having to supply the total braking power, its function is merely to open a small valve.

All Power Makers dealt with at the **International Electrical Congress** *will be treated in our St. Louis number (November).* **See that you get a copy.**



A classified list of Traction and Transport articles will be found in the World's Electrical Literature section at end of magazine.

The Modern Electric Industrial Locomotive.

HE industrial locomotive operated by electric power is extensively employed throughout Europe and America, and is being introduced more extensively each year. In some cases the storage battery electric locomotive is preferred, while in others the trolley locomotive is found to give best service, and in many cases where the storage battery is found desirable, a trolley pole is provided for taking current from the overhead line, charging the batteries at the same time it is in service, to be used when the switching or other work requires that the locomotive leaves the section covered by the trolley line, as when crossing the steam railway tracks.

The industrial locomotive shown in Fig. 1 was constructed at the Baldwin locomotive works for the Atlantic Coast Lumber Co., and was designed for service on a gauge of 4 ft. 8½ ins. This locomotive is of the overhead trolley type, and is equipped with two motors operating at a pressure of 220 volts. The weight of the same is 24,700 pounds, and it measures 13 ft. in length, 10 ft. in height, and 7½ ft. in width. It has a wheel base of 5½ ft. and the driving wheels measure 30 ins. in diameter. The Hungarian electric locomotive in Fig. 2 shows one of the industrial type constructed for a direct current trolley line by Ganz and Tarsa of Budapest. At the glass works of Schott and Genossen at Jena, it is stated that by means of the electric locomotive an enormous saving has been effected increasing the output, and handling the whole traffic of the large glass works in addition to the transport of all the coal required.

It is acknowledged generally that power cannot be transmitted long distances by compressed air as economically as it can by means of electricity. It is, however, well known that for mining operations, in driving certain tools, for mine haulage and shunting or switching cars in yards of large manufacturing plants, the compressed air locomotive has many points of advantage, although under certain circumstances the electric locomotive has decided advantages over the compressed air type. When heated air is used with the compressed air locomotive, its sufficiency is materially increased. But this advantage over the use of cold air is prevented in mines having dangerous gases in them, which are liable to explode from being ignited by the reheating burner, and also in certain industrial plants where explosives are manufactured or stored. In manufacturing plants where explosives

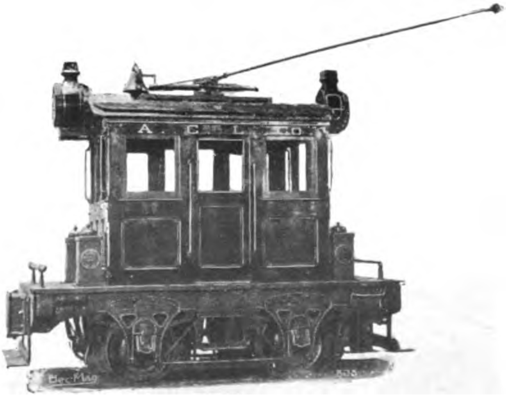


Fig. 1. Baldwin Electric Locomotive.

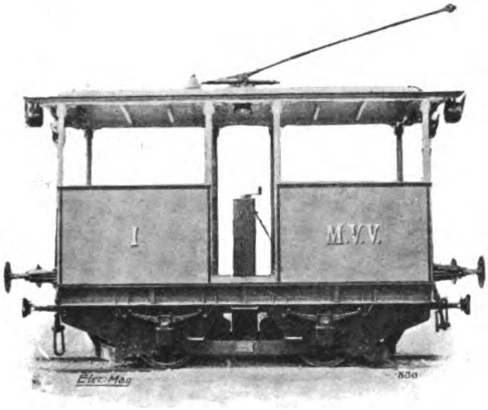


FIG. 2. GANZ ELECTRIC LOCOMOTIVE.

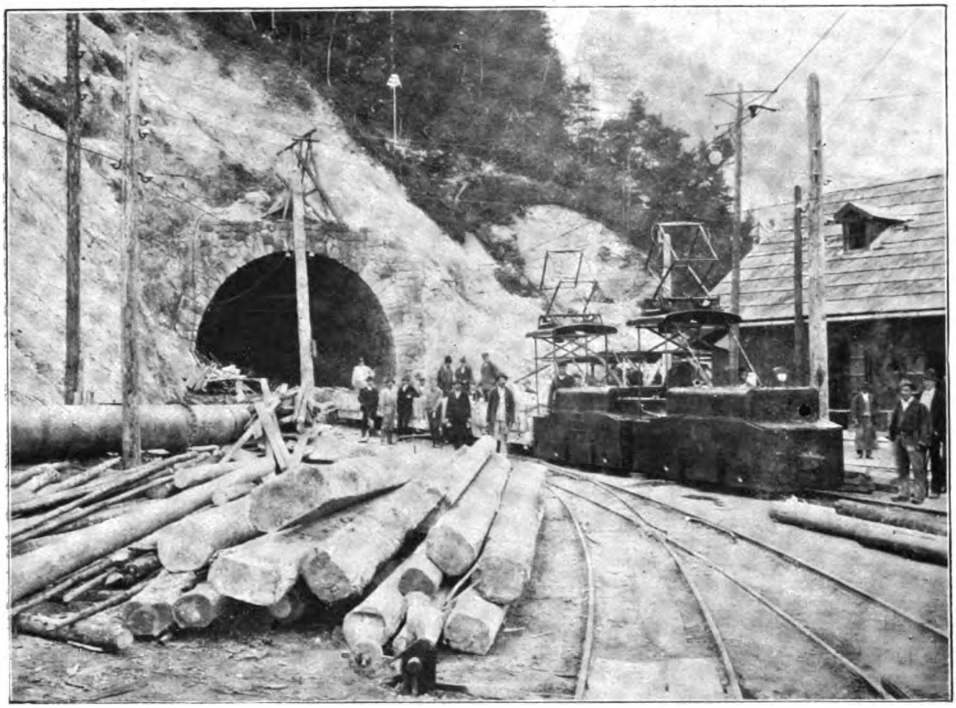
and other dangerous chemicals are used and manufactured, the compressed air locomotive using cold air is far superior to either the steam locomotive or the electric locomotive. In using cold air in the locomotives it is claimed by engineers who are familiar with the operation of these machines that for these purposes the working compared with the electric haulage is simpler, more reliable and not subject to breakdowns and interruptions, being also absolutely safe in gaseous mines where electricity is as dangerous as steam. They also suggest that it is more flexible and convenient inasmuch as the compressed air machine is complete in itself, able to reach all parts of the mine or yard wherever a track is laid without requiring an overhead line. The electric storage battery locomotive is now being extensively used, and is claimed to have many similar advantages over the trolley locomotive that the compressed air machine has. There is little question but what the maintenance is greater for the storage battery locomotive than with the compressed air outfits: but the electric and compressed air locomotives have each a field of their own, and there are many cases where one has advantages over the other. Electricity is without doubt a most convenient and economical form of motive power for industrial as well as mine haulage, and certainly in frequent cases has marked advantages over the compressed air system.

As regards compactness the electric locomotive has slightly the advantage as to size for a given output, and they are about equal as to the use of the same source of power for other purposes, as compressed air is extensively used in machine shops for driving various machine tools as well as in mines where cutting tools, drills, and other compressed air motors are in continual operation, the air from all the compressed air machinery, including the mining locomotives, being available for the ventilation of the mines, which is well worth consideration. In industrial plants as well as in many mines, electric power is generated on a large scale, and is utilised not only for driving the electric locomotive, but is employed for operating pumps, ventilators, hoists, cranes and all the various machine tools and labour-saving devices employed at the present time. The greatest economy is obtained where the electric locomotive is employed in industrial works using electricity for other purposes, as for operating, drilling, and hoisting, and other apparatus as well as for lighting the establishment with incandescent and arc lamps. The electric industrial locomotive is very seldom called upon to operate at greater speeds than eight miles per hour, and it is designed to be able to develop full load tractive effort at about this speed. The weight of train which a given electric or air locomotive will haul at standard speed on a straight track, will vary according to the grade and frictional resistance of the cars. The frictional resistance varies according to the condition of the track and the condition of the car and locomotive journals, ranging from 30 to 80 lbs. per net ton weight, while even the latter figure may be exceeded in exceptional cases where the cars are badly worn out of truth.

The storage battery locomotive has been designed both with batteries mounted on the top as well as with batteries located on a separate track. In many cases electric storage battery locomotives are provided with trolley poles and connections so as to be able to operate from the trolley line if desired, and have the batteries under-charging current at the same time, the current from the batteries being available for use when the electric locomotive must pass steam railway tracks or operate at a distance from the trolley line of the industrial plant.

Electric Locomotives in Tunnels.

THE electric railway and locomotives for the Karawanken Tunnel (the power equipment of which we describe in our Power Section this month) were supplied by Siemens and Halske and the Maschinenfabrik Andritz A.-G. These electric locomotives are required to handle six loaded cars of material, each weighing 4.2 tons, or together 25.2 tons on a grade of 35 per cent., the smallest curve having a radius of 81 yards. Or they are required to handle a train of fifteen empty cars, each weighing 1.2 tons, or together 18 tons on a grade of 50 per cent., with the same minimum curve-radius.



LOCOMOTIVES AT THE KARAWANKEN TUNNEL.

They are also required to handle twenty-five empty cars and twenty-five loaded cars, representing 150 tons on a low grade of 6 per cent. The track of this tunnel is 2 ft. 6 in., and the maximum drawbar pull of the locomotive is 6,380 lbs. Two of these electric locomotives are coupled together, forming a double locomotive with single control. Each axle is connected to a direct-current railway motor of 25 h.p. capacity. The normal speed of these locomotives is 6¼ miles per hour, and three of the double electric locomotives were operated on the south side of the tunnel, the total length of the trips being 4½ miles, while the grades varied up to 50 per cent. For operating the electric locomotives, a direct current was required, and this was supplied from a sub-station, which was connected with the Rothweinbach power-station transmission line and equipped with step-down transformers and a rotary converter. The sub-station received the current from the transmission line at 5,000 volts, and two stationary step-down transformers of 230 kilowatts each were provided for lowering the pressure to 350 volts. The sub-station was also equipped with a rotary converter of 250 kilowatts capacity provided with double armature windings, one of which received the three-phase current through slip-rings at a pressure of 350 volts, while the other winding was connected with a commutator and delivered a direct current of 560 volts pressure to the railway feeders. The rotary converter has eight poles and is operated at a speed of 750 revolutions per minute. It is provided with a small six-pole asynchronous motor for driving the rotary up to synchronising speed. The electric railway overhead-line consists of a bare copper wire of 80 mm. cross-section. The rails are connected by copper wires as binders, and carry the return current, the loss of pressure being about 10 per cent. at the longest distance from the sub-station. The outside lighting is supplied by twenty-six arc lamps of 1,500 c.p. each, while the inside lighting is provided by 618 incandescent lamps of 16 c.p. each. The lighting current is supplied by the Rothweinzentrale by transformers of 60 kilowatts capacity, the pressure being 190 volts for the arc lamps and 110 volts for the incandescent lamps.

New York Subway.

The New York Subway is a work of engineering skill which may well claim the admiration of all engineers and citizens alike. The provision of adequate transport for its teeming millions is a problem in which men of the highest reputation have been engaged, and now that their

labours are approaching consummation it will be interesting to glance briefly at what has been, is being, and will be done. That portion of the Rapid Transit Subway embraced by contract No. 1 is nearing completion, and will, we understand, be shortly opened for regular traffic. It includes some twenty-one miles of line, in which is a fourteen-mile length between New York City Hall and a point near the New York and Putnam Railway. From this length a seven-mile arm extends from 101st Street to the Borough of the Bronx. From City Hall to 104th Street there are four tracks, thence to 145th Street three, and then two tracks are run as far as the Manhattan Valley viaduct. On this latter three tracks run to the end of the line. The branch line has two tracks to Melrose Avenue, and then over the elevated structure there are three tracks to the end. Where trains do not continue down town beyond certain stations loops are run *under* the main tracks to permit the return of trains without crossing the main metals. The first-mentioned length touches at forty-eight stations, ten being on the elevated structure and the rest underground; the branch line touches eight stations, four in Brooklyn and four on the New York side. With one or two exceptions the subway stations are quite close to the surface, the exceptions being fitted with electric lifts. On the very high elevated stations, moving stairways accommodate the passengers. To the details of construction we must refer later when illustrations of the plant and rolling-stock are forthcoming. Nine sub-stations with 1,500-k.w. rotaries feed the line, the main power house furnishing three-phase current at 11,000 volts. The main station is at 48th and 49th Streets and is a large building, 700 ft. long by 200 ft. wide. The present equipment in nine large corliss engines and fly-wheel generators totals 75,000 h.p. In addition to these three 1,250 k.w. turbines are installed. The rolling-stock is completely modern in every detail. The cars seat fifty-two persons, and every precaution has been taken to make all cars fireproof. The motor-trucks are fitted with two 150-h.p. motors, each representing a tractive effort of 3,750 lbs. at twenty-five miles per hour. All motors are nose-suspended and can be removed without having recourse to a wheel-pit. Express trains will comprise eight cars, three being motor-cars. The motors are controlled by the Westinghouse electro-pneumatic system of train-control, and this company's automatic block signalling system is also installed throughout the line. Every detail has been thought out in the instruction of the motor men. Special cars have been provided and examinations have to be passed. (See Traction Notes.)

GROWTH OF MUNICIPAL TRAMWAYS.

In his presidential address to the Municipal Tramways Association of Great Britain, Mr. C. R. Bellamy, Liverpool, said the municipalisation of British tramways was making steady progress, about 215 additional miles of tramways having been applied for during the past session, at an estimated cost of over five millions. He urged that ever-increasing net-works of municipal tramways with connecting links might quickly provide the whole country with a system cheaper in operation than was contemplated under the Light Railways Act by making the most effective use of the public highways. It might be possible, in addition to other benefits, to produce in our country the forty millions worth of food-stuffs now imported annually. Among the papers read, one by Mr. Peter Fisher, manager of Dundee Corporation Tramways, dealing with the subject "Economy in Consumption of Current," is deserving of attention. Appended to the paper were the tabulated results of a valuable series of observations compiled from information supplied by municipal managers throughout the country. At the outset of his paper, Mr. Fisher laid insistence on the necessity of accurate metering at the power station, indicating how in his view this result could best be obtained. The importance of constancy of potential over the system was emphasised, it being pointed out that careful experiments had shown that with a drop of twenty to forty volts the current required had increased from 5 per cent. to as high as 15 per cent. In connection with the training of motor-men in the economical use of current, Mr. Fisher said that with the introduction of electric traction, what immediately concerns the manager is that he should have motor-men capable of driving the cars so as to give a service free from accidents and irregularities; the care of the car equipment will then receive special attention. After the service had got fairly started, the question of economy must be considered. The manager very soon discovers that some men operate their cars in a more intelligent and careful manner than others. One man brings his car to a standstill at the various stopping-places without the slightest effort, the next man approaches the same place pulling for all he is worth at the brakes, unnecessary waste of current taking place during the latter operation. The condition of the rails in foggy weather and in towns where the transport of materials over the streets tends to form a greasy surface on the rails, has a decided influence on the consumption of energy. One correspondent puts the increase from such causes as the

above from 5 per cent. to 8 per cent., and several other managers emphasise the importance of keeping the rails clean with a view to increasing the grip of the wheels and providing the best possible return to earth. Information supplied in reply to inquiries shows that the current used on bogie cars exceeds the consumption on single truck cars by about 27 per cent. Further information acquired in the same way, is to the effect that economy results by converting bogie cars to single truck cars. Tests made with the two types showed that a bogie car on maximum traction trucks, seated for fifty-nine passengers, required almost 40 per cent. more energy than a single truck seated for fifty-one passengers. The tests referred to were made on a line very favourable to the bogie car, inasmuch as a considerable portion of the route is on curves Whatever advantages the bogie car may have over the single truck in other respects, its disadvantage as regards consumption of energy is very considerable.

ELECTRIC TRACTION AT THE CONGRESS.

THE activity now being displayed in manufacturing circles with electric traction motors but naturally gave rise to much of the discussion of this important subject at the International Electrical Congress. As was to be expected many of the papers down for reading were only briefly touched upon, many being simply read by title. The discussion turned generally on all the papers read, and was very instructive in character. P. M. Lincoln gave some good reasons for the adoption of single-phase traction, but other speakers favoured three-phase as the strains were more equally distributed, as in a triple-expansion engine. Further three-phase might be operated from two transformers in case of breakdown to one, making the service more reliable. Prof. C. P. Steinmetz said the single-phase induction motor was quite out of the question for railway work, except with such a system as Arnold's Electro-pneumatic (*See* THE ELEC. MAG., vol. i., No. 4, p. 383). The single-phase commutator motor was much to be preferred, approaching the direct-current type in its characteristics. He did not approve of polyphase railway working, and thought single-phase was much more desirable. The simplicity of single-phase quite outbalanced any of its disadvantages. Mr. Ward Leonard referred to his system of traction, and in comparing it with the Arnold, considered it was simpler in having only rotative parts. The discussion turned chiefly on the relative merits of single-phase and three-phase railway systems, there being no very striking statements made which might be expected to hasten the conversion of steam railways to electrical operation. Mr. Lamme referred to a three-phase system in which with Scott transformers two-phase was obtained and feed both ways into the line as single-phase. In our next issue we shall refer further to the papers read and discussed.

INTERURBAN ELECTRIC RAILWAYS.

MR. E. GONZENBACH, writing in the *Railroad Gazette* on the future of interurban railways, says: "The lesson taught by the success of many of the interurban roads is, that the part of the public obliged to travel wants comfort, and when that is provided, the balance of the public will find an excuse to travel, if rates are reasonable. To provide this comfort is not quite as easy as the word. It means more than handsome, well-appointed, easy-riding cars. Suppose these are provided and one must wade through muddy depths to get at them, or must undergo the annoyance of waiting for cars behind time, or endure a rough track and poor trucks; no amount of beauty in the car will make up for this. Comfort to the passenger should begin when he makes up his mind to take a ride on the road. He should have only a short walk to the car. Perhaps board it in front of his place of business, and it should be on time. Once seated, the car should get out of the way of impediments to quick time as promptly as possible. Getting to his destination, the passenger will want to be let off to his best advantage, and his comfort must be considered even after he is out of sight of the car. If it is not possible to pick him up and deposit him to suit his convenience, then the next best thing the road can do is to provide him with a comfortable and attractive place in which to wait. During his ride he does not want to stop oftener than can be helped; the speed of the car in miles per hour does not interest him, but he is vitally interested in the total elapsed time from the beginning to the end of his journey. Even if it is a pleasure ride and time does not count, he would rather ride twenty miles in one hour making no stops than the same distance in the same time making from fifteen to twenty stops, but reaching a maximum speed between stops of 50 m.h.p. To be convinced of this try it yourself. Neither are hold-ups at grade crossings any additional comfort to the passenger—nor to the operating company. This naturally brings forth the argument that, after all, one of the most vital parts of any railroad property lies in its terminal facilities, and the rule holds good whether the road have steam, electric, cable, or mule motive power. This is especially true in the

large cities, and no better illustrations can be cited than the two cities of New York and Chicago."

TRACTION NOTES.

St. Louis Day and Local Railways.

On September 15 last, "St. Louis day," the traffic to the Exposition was successfully handled by the street railways, which made special provision for it. The St. Louis Transit Co. ran about 1,180 cars and from counts at the corner of Olive and Twelfth Streets at 9 A.M., forty cars in fifteen minutes were passing. The total revenue was $1,151,785. The St. Louis and Suburban Railway Co. carried about 141,000 people and operated about 134 cars. Everything went off without hitch and the various companies were congratulated by the press on the result.

Controller Burn-Outs.

The continued trouble experienced with controllers on large cars was commented on in the *Street Railway Journal* recently, and the cause was attributed to the comparative stagnation of controller designs despite the increase in car and motor sizes. Where 8-ton cars were accustomed to accelerate with 60–130 amps., 18 to 25-ton cars now demanded 160–400 amps. for accelerating. As the controller had been little modified to cope with such largely increased currents and correspondingly large arcs, they were frequently found wanting. Again, defects in the car wiring imposed short circuits which were generally broken at the controller, as the station circuit breakers were always set high. Our contemporary thinks that the problem of handling successfully heavy currents or cars is calling for the best that electrical engineering can provide to cope with it.

The Instruction of Motor-Men.

The Interborough Rapid Transit Co., New York, to whose subway we briefly refer elsewhere, has adopted an elaborate system for the instruction of the drivers on its elevated and subway tracks. Special cars are provided in which the entire brake equipment and accessories are open for inspection. Tuition in driving is given by competent instructors, and among other literature circulated is a neat instruction book on the whole equipment of the car, illustrations and diagrams being generously distributed throughout the pages. All parts are carefully numbered and minutely described, and there is little excuse for any employee to plead ignorance of the apparatus in his charge. Numerous questions are asked and answered on the air brake, and the multiple unit system which is described and fully illustrated, is similarly dealt with. The booklet is neatly bound in cloth, and all the illustrations are well reproduced.

Electric Traction on Russian Canals.

The canals of Ladoga alone constitute about 42 per cent. of the total mileage of canals in Russia. Partly for this and because they terminate at St. Petersburg, the traffic on these is extremely intense, having reached in 1900 the important total of four million tons. The freight consists chiefly of timber and corn, and may be estimated at 500 kilometre-tons daily. Till now animal traction has been employed, about 10,000 horses being annually required for this, there being no traffic during the cold months. From a scheme worked out by an engineer, Mr. Rundo, the transport rates which actually amount to from 12 to 32 kopecks per verst, could be reduced to from 2.25 to 3.5 kopecks by the introduction of electric traction. The Russian Minister of Public Works has been considering several schemes, some of which utilise water and others steam-power or gas. In either case naphtha would be used as fuel, as it could be transported on the Volga at very small cost.

The Utica Convention.

The Street Railway Association of New York State held its 22nd annual convention on September 13 and 14 last, and we understand that the meeting was very largely attended. The President in his address referred to the progress of street railways in the state during the past fiscal year, the mileage increase being 111. He deplored the present systems of train despatching, especially on electric roads, stating that more accidents had occurred during the past year from errors in this direction than from any other. Head-on collisions had occurred on two roads using the most perfected system of train despatching. Package and parcel business was rapidly increasing, but would do with further expansion. All the papers read had an important bearing on Street Railway affairs, the subject of freight traffic being specially dealt with. Block signalling from track circuits was fully discussed, and in fact all the papers read were subjected to considerable criticism, though chiefly of a friendly character. The report of the Committee on high-voltage transmission lines was also presented, and embodied many important deductions. We refer to the convention in the Editorial Notes.

A CORRECTION.

Dolter Surface Contact System.

In our last issue it was stated by Mons. Vingoe, in his article on "Surface Contact Systems in France," that the Dolter system had just failed to be accepted in Dresden. It now appears that this statement had no foundation in fact, and we regret that it should have appeared in our columns. A trial line in that town is in actual process of installation at the present time.

Readers are referred to the World's Electrical Literature Section at end of Magazine for titles of all important articles of the month relating to Lighting and Heating.

The Operation of Alternate Current Arc Lamps in Series.

By the ASSOCIATE EDITOR.

THIS system of lighting, which has of late years become increasingly common in America, has many advantages from the point of view of simplification in practice. Naturally, the lamps are of the enclosed type, and there then remains such question to be settled in laying out an installation as the voltage to be allowed for each arc, or the current to be taken by the lamps. Speaking generally, it should be said that a minimum of seventy volts should be allowed for each arc and a maximum of seventy-five. Within these limits things are likely to go well, though the figures may be somewhat lowered if carbons are used impregnated with some salt, like those of sodium or potassium. It has been usual to refer to a 9.5-amp. 52-volt arc of the open type as a 2,000-c.p. lamp, although, accurately speaking, there is little ground for such an assertion. These lamps are about equivalent to a 7.5-amp. 70-volt alternating enclosed arc lamp; the illumination in the latter case is much more uniform, though its average is probably slightly less. Still, as a working unit its usefulness is greater, it has freedom from well-defined light and dark bands, and the colour of its light may be made to be fairly good. Lamps taking very small currents are liable to be unsatisfactory, owing to the colour of their light, which may be markedly violet or blue. Such lamps should be avoided unless carbons of greater density are used and of smaller cross-section; and even so in this case the lamps will require to be placed fairly close to one another. As for globes, a large amount of experience is now available, and much work has been done in testing the light-emitting properties of various forms of glass. Probably the best arrangement is to use a slightly opalescent inner globe, and to keep the outer globe of clear glass. Blackening of the inner globe may generally be traced to insufficient ventilation. During the burning of the lamp a certain amount of carbon becomes volatilised in the arc, and unless it is burnt to an invisible vapour it is deposited on the surface of the globe in a film, which becomes denser and blacker as time goes on. The remedy is to admit a sufficient but not excessive supply of air, in which the oxygen, by combination with the glowing carbon vapour, forms carbon dioxide, which escapes, or should escape, without leaving any visible trace behind it. Of course, a lamp which was originally properly proportioned in so far as ventilation is concerned when it first left the hands of the manufacturers may be put out of adjustment by the use of too large carbons. On the other hand, if the voltage of the arc falls too low, there is a liability to the occurrence of a similar blackening, though due to a different cause. In this case, with a short arc, it is possible for the temperature within the globe to fall so low that the vaporised carbon can escape to the surface of the globe without coming in contact with oxygen at a sufficient temperature to cause combination or the formation of carbon dioxide. In this case, too, a coating of carbon would be formed on the surface of the globe, and might become very noticeable between two successive trimmings. In spite, however, of all precautions, a certain amount of deposit is always formed, due to impurities, such as silica and iron oxide, in the carbons. The material of which the gas-cap is constructed is not a matter of indifference; brass, iron, and metal of any description should be avoided, and some refractory

non-conductor should be preferred. It will tend to keep cooler, and consequently the deposit from the arc will tend to cover it more readily than it would do if the material out of which it is constructed became hot. In this way a large portion of the deposit can be diverted from the inner globe, and deposited on the gas-cap, where it does little or no damage from the point of view of obscuring the light.

Modern Projectors.

SCARCELY more than ten years ago glass reflectors of 90 cm. diameter were regarded as a considerable advance in the technical world. These reflectors were largely employed by armies and navies of all nations; and as the result of experience gained in manufacture it was found possible to make parabolic reflectors of 1.1 metres diameter. At the Frankfort Exhibition a projector was shown having a diameter of 1.5 metres; and a similar one made its appearance at Chicago in 1893, and its light could be seen at a distance of seventy miles. It was bought by the Government of the United States, and is now in a lighthouse at Sandy Hook. Projectors of equal size, with glass parabolic reflectors, have since been erected in England, Germany, and Russia. Since that time even larger machines have been constructed, notably one which was the first of its type, and was shown at the

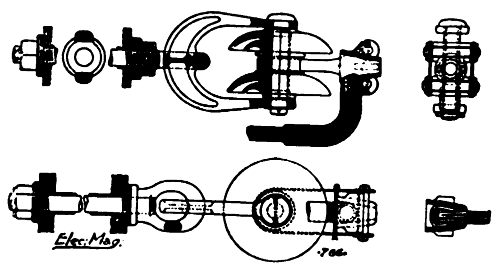
SCHUCKERT PROJECTOR AND REGULATOR.

LARGE SCHUCKERT PROJECTOR.

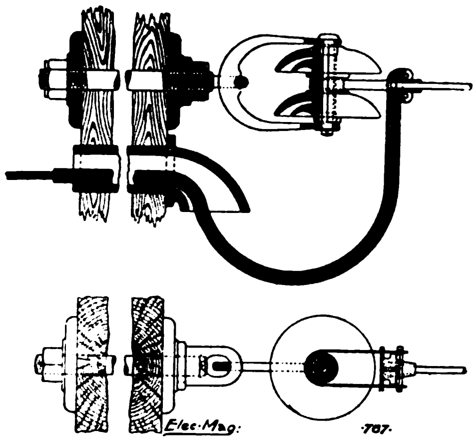
Paris Exhibition, having a diameter of two metres. It was constructed by the well-known firm of Schuckert and Co., to whom a large part of this class of work has fallen, and who were also responsible for the various projectors referred to above. Our illustrations give a general idea of the outlines of the Paris projector. It is the largest projector in the world, its parabolic mirror having a maximum diameter of 2.06 metres and a useful diameter of two metres. The largest hitherto constructed had only a diameter of 1.5 metres. It is constructed to burn 200 amperes; the carbons have diameters of 49 mm. and 35 mm. respectively for the positive and negative electrodes. The focal length of the mirror is 869 mm. The precision with which it is made is such that rays which fall on the mirror parallel to its axis are reflected in such a direction that they cross the axis at the focus within a sphere of 2 mm. diameter. This gives an idea of the accuracy with which it is now possible to make a mirror of this enormous size. The candle-power of the emergent beam has been found to be 316,000,000. It is provided with an iris diaphragm, which serves to contract or enlarge the beam; it can be opened or closed by hand, or by connecting it to a commutator which can be worked from a distance, in common with the various controlling devices for the other parts of the mechanism. In our illustrations the various details are sufficiently plain without elaborate description. In the one, a man is seen standing at the commutator, and the regulating mechanism of the lamp is seen on the outside of the case at about the height of the man's head. The interior is also plainly visible, and shows the method of supporting the carbons, and the devices for adjusting them. The iris diaphragm is folded back beneath the outer ring; the hand-wheel is, however, seen by which it is opened and closed. The projecting portion at the top is intended to allow of the examination of the arc, and the relative positions of the carbons. The body is supported by semi-circular supports, which are furnished with steel balls as bearings. The movements of the body of the projector are carried out either by hand through small hand-wheels, which are seen in both illustrations, or by means of a motor. It is capable of motion in all directions, about both horizontal and vertical axes. The first illustration shows the apparatus as seen from the left-hand side, and in this the diaphragm is seen half-closed, and the motor by which the diaphragm can be worked is seen immediately behind the hand-wheel on the case. The rate at which the movement of the diaphragm is carried out can be controlled by means of regulating resistances from a distance, if the operation is carried out by electrical means.

NEW SYSTEM OF WIRE FIXING FOR OVERHEAD CABLES.

In America and other countries where the use of overhead wires is common for all sorts of purposes, and where things appear to be left, in the absence of official regulations to be decided by experience or by a system of trial and error, it has gradually been recognised that the fixing employed for the suspension or overhead cables is capable of improvement. We illustrate herewith the proposals of M. Astafieff, which are to be given a trial. The advantages of his system, which has been worked out with such thoroughness, are that the apparatus is subjected only to longitudinal strains, and bending and twisting effects on the wire are said to be eliminated. In a word, the apparatus is more mechanical in its design, though more complicated in its outline, than the familiar porcelain insulator and its pin. As shown in our illustration, the porcelain insulator adopted in the Astafieff system is of the double-bell form. It is connected by the



APPARATUS FOR SUSPENDING OVERHEAD CABLES.



FIXING BRACKET FOR OVERHEAD CABLES.

metallic parts on the one hand to the fixed part of the apparatus; on the other side it is connected with line wire, which it is intended to insulate. The weak spot in these things is always the porcelain insulator. In this case, it is held by a ring of metal; so that in the case in which breakage occurs through strain or other cause, the insulator is held in position, even if broken in pieces, and is capable of doing effective work till inspection reveals and removes the fault.

STREET LIGHTING.

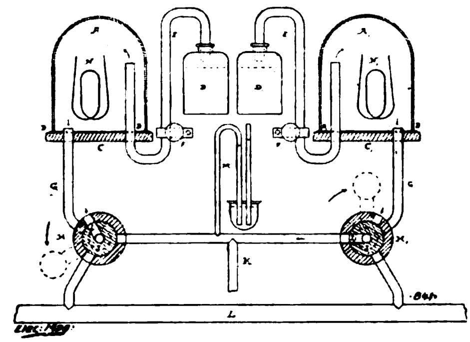
IN America a large amount of work is still done on what appears to us to be old-fashioned lines in the matter of street lighting. The high-pressure direct-current system is little heard of in England nowadays. For some reason or another, it has gone out of fashion, but on the other side of the Atlantic it is still very much to the fore. Mr. J. H. Hallberg has lately discussed various systems under which it is possible to carry out arc lighting by means of enclosed lamps of low candle-power. The ordinary distributing pressure in America may be taken as being 118 volts. Therefore, if the lamps are to be lighted off the mains in parallel with one another a considerable number of volts will be lost in series resistances. The most favourable design is for direct-current lamps taking three amperes at 85 volts, or for alternate-current lamps taking four amperes at 72 volts. It is therefore not surprising to find an overall efficiency of 72 and 87 per cent. in the two cases respectively. Added to this there is the difficulty or expense of switching the lamps on and off; automatic switches are never satisfactory for any great length of time, and failing them, the expense of switching on by hand is generally prohibitive. The series system is better; with either direct or alternate current it is possible to have an efficiency of about 94 per cent. It is claimed that the direct-current system is the better under these conditions, owing to the colour of its light. But from our point of view, this merely lands us on the horns of a dilemma, for our central stations do not generally provide machines capable of lighting fifty enclosed direct-current lamps in series. On the contrary, the newer fashion of alternate-current lamps in series on the enclosed system has been but little tried in this country, and it is to be hoped that in the near future it will receive a more extended trial.

MR. WILMSHURST'S PROPOSALS.

THESE proposals, to which we referred in our last issue, continue to receive public attention, and the discussion of them has revealed a great difference of opinion. It will be remembered that Mr. Wilmshurst proposed that central station engineers should exercise a benevolent interest in the condition of their consumers' installations, and should supply them with lamps at cost price. It is evident that such work as this would add very greatly to the routine work of the station; and it would be scarcely possible in any station, of whatever size, to carry out such an undertaking without an extra staff. With small stations, it would need an extra man; with the larger ones, it would need several. Added to this, others point out that offers similar to those suggested have been made by them in their district with negative results. At any rate, the result is not what was expected. Probably, it is the old tale over again in a new form, and amounts in fact to a variation of the saying that a man does not value that for which he does not have to pay. One station engineer points out that he has long offered to supply good lamps to his consumers at cost price, and has warned them against the practice of running them too long. He finds now that if the consumer lives more than a mile from the station he hears nothing from him. In fact, the prospect of having to walk a mile makes him think it better to bear the ills he has than to run the risk of wearing out so much shoe-leather. The contractor's voice has not been much heard in the discussion. Probably he is wise enough to know that little is likely to come of the proposal, even if it is adopted theoretically—that is to say, by way of printed notice to consumers.

FLASHING INCANDESCENT LAMPS.

THE flashing of incandescent lamps is a well-understood operation; and the following is a general description of the mechanical arrangements, adopted in America, and described by Mr. Ralph McNeill. From the diagram the outlines are fairly evident. The two filaments are suspended in clamps in bell-jars standing on rubber gaskets supported by brass bases. These bell-jars communicate through stopcocks F to gasoline reservoirs on the one side, and through stopcocks H to air-pumps on the other side. At first, stopcock H is so arranged that communication is made with L, and through it with a large air-pump, which rapidly effects a preliminary exhaustion; H is then turned so that connection is made with K, which leads to a high-vacuum air-pump, the manometer M showing the degree of vacuum reached. The stopcock F is finally slightly opened and gasoline vapour is gently drawn through the bell-jar under the vacuum there existing; the current is turned on, and carbon is

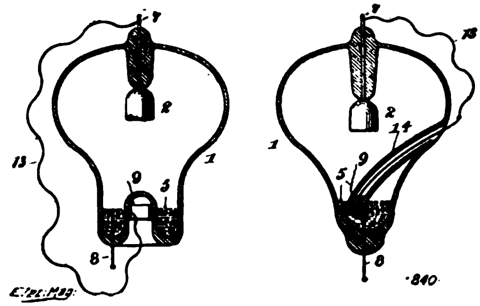


APPARATUS FOR FLASHING INCANDESCENT LAMPS.

deposited until the resistance of the treated filament is about half of what it originally was, its resistance being determined in the usual way by means of the Wheatstone bridge. Experience shows that a filament treated to this extent works well in practice, though a certain amount of latitude is permissible.

STARTING DEVICES FOR THE COOPER HEWITT LAMP.

HEREWITH we show two of the latest devices patented by Mr. Hewitt for the starting of his lamp. Originally he preferred a so-called "starting band," which was placed outside the container; the later development differs only inasmuch as the band is placed, as it were, within and somewhat above the mercury vessel. Our illustrations will make this plain, and show two slightly different forms of an arrangement which is capable of a

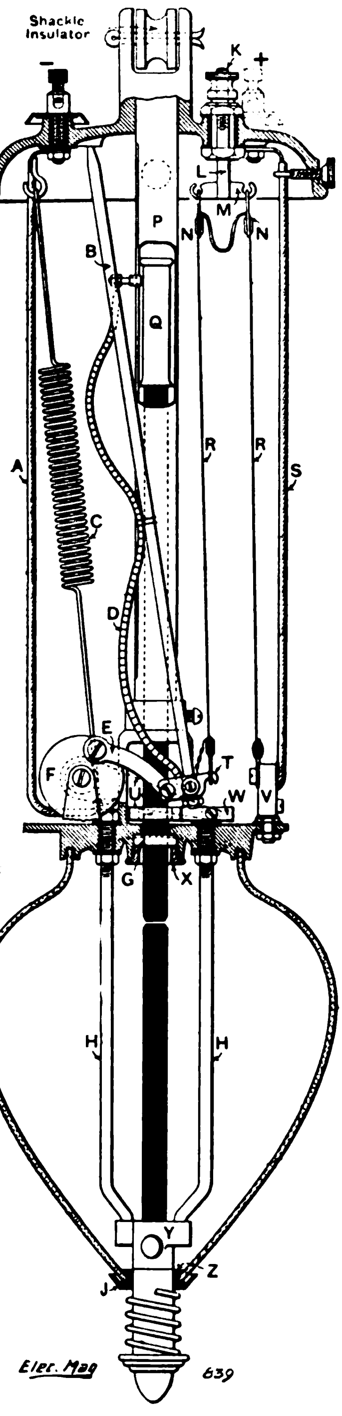


STARTING DEVICES FOR MERCURY LAMPS.

vast number of small practical variations. In both, the electrodes are marked 2 and 8, and the "starting band" is marked 9. In the first, it consists of a ring which can be made of a strip of metal-foil, or of a metallic paint; it is so placed as to be within and yet slightly above the mercury in the container. It will be seen that this is made possible by the employment of a specially shaped bulb. In the second form, a connection is made by means of a special passage through a glass channel, which is marked 14, with a drop of mercury at the bottom of this passage, which is labelled 9. This mercury drop constitutes the starting band, and a device of this nature is found in practice to work well. Apart from difficulties in glass-blowing, the second method appears to be preferable to the first.

THE FOSTER ARC LAMP.

THIS new type of lamp dispenses with the familiar solenoid as a controlling force, and uses instead of this a hot wire. The general design is shown in the accompanying diagram. The current passes through two metal strips RR, which expand and contract with the increase and decrease of the current. The current passes from R to the hook T, and thence by a flexible connection D to the upper carbon-holder; then through the arc to the lower carbon, and thence to the other terminal of the lamp. An increase of current causes R to lengthen; the hook T, which is steadied by the strut B, pivoted at its upper end, moves slightly to the left under the influence of the spring C; the result being that, due to the influence of intervening links and a clutch, the carbons are separated, and at the beginning of operations the arc is struck. A decrease of current produces, of course, the opposite result of feeding the carbons together. The tension of R can be varied by means of the screw K, and in this way the accurate working of the lamp receives a final adjustment. These lamps, which are generally of the enclosed type, are naturally suitable for either alternate or continuous current. They are made by Foster and Co.,



THE FOSTER ARC LAMP.

of Worple Road, Wimbledon; and, as is only right, they have made their *début* on the local circuits of Wimbledon, where they have given such satisfaction that a larger number is now on order. The lamp weighs only 12 lbs., and its simple design and construction are distinctly points in its favour.

LIGHTING AND HEATING NOTES.

Photometric Experiments with Selenium.

IN the columns of the *Electrical Review*, New York, recently, there appeared an important article on the use of selenium for photometric purposes. The chief difficulty in improving electric lamps has been experienced in providing a photometric test independent of the human eye. The article in question explains how selenium may be employed for photometric purposes, and the method has promises of commercial value. In another issue we shall give an abstract of the article with a few of the illustrations employed.

The Edison and Swan Electric Light Co.

THE history of this company, which has lately been published, is of much interest to those with short memories. In 1880 Edison and Swan independently reached the goal, as they believed and accordingly took out their patents. They then formed separate companies to exploit their patents, and finding themselves at loggerheads with one another and likely to be engaged in ruinous competition, both legal and otherwise, they decided to amalgamate in this country. Accordingly in 1883 the Edison and Swan Electric Light Company was formed. Until 1888, when the Electric Lighting Act was passed, there was no great commercial scope for the sale of lamps. But from that year down to 1894, when the monopoly expired, good business was done, though the price of the lamp was kept between two and three shillings. In 1894 the profits were £27,900; but in the following year, when free competition began, the profits fell to £19,400. The sanguine forecast, which persuaded Edison to sell his interests for deferred shares in the company, has not been altogether verified, seeing that these shares have only once received a dividend, which amounted to 3 per cent. After 1896 there followed several satisfactory years, and this was partly the result of an extension of operations on the part of the company into the field of the manufacture of electrical fittings. Latterly, however, things have not been any too flourishing, largely owing to faults of early management; but new blood on the Board and the concentration of their interests at Ponder's End, accompanied at the same time by the closing of unprofitable works both in England and abroad, has led to a revival of the early confidence and the possibility of continued usefulness. Altogether it can hardly be said that the most was made of the early years, in which they had a monopoly, to thoroughly consolidate the business. Overconfidence was too great, as also was the fall in prices when competition set in. But the company is now once again on a sound foundation, and though the quotation for its shares is low, they would probably constitute a profitable speculation for anyone who is content to lock up his money for some time.

For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section at end of Magazine.

Telegraphs and Telephones in South Africa.

By E. O. WALKER, C.I.E., M.I.E.E.

THE telegraph service of South Africa is growing rapidly, and the Postmaster - General of the Cape Colony, considers that it is desirable in the general interest that uniform regulations and treatment should be adopted throughout the country. This can only be achieved through the establishment of a Central Bureau on the lines of the International Bureau at Berne, the special business of which would be to receive all proposals originated by each country of the Union, to circulate them, and announce the decisions come to. Through the post offices of the Colony there were transmitted over thirty thousand telegraphic money orders in the year 1903, of the gross value of £173,000, and showing an increase of 13 per cent. over the previous year's business which is highly satisfactory.

Twenty-eight new telegraph offices were opened making a present total of railway and of postal telegraph offices of 528. A reference is made in the Annual Report to the visit of Mr. Chamberlain. A special staff accompanied him in order to deal with the large amount of telegraph traffic involved. By means of fast repeaters at Kimberley, Beaufort West, and King William's Town, it was found possible to transmit to Pretoria, Johannesburg, Bloemfontein, Durban, Kimberley, East London, Port Elizabeth, and Cradock simultaneously by means of the Wheatstone apparatus, the length of telegraph line thus "forked" approximating to 3,000 miles. During the tour half a million words were telegraphed. The arrangements proved most successful.

In 1903, new lines of 194 miles in length were erected and over 3,000 miles of wire added. The posts used are mostly those of Messrs. Siemens' pattern. Many are fitted with tube arms, and also with tubular malleable iron single brackets. The wires are mostly supported on white porcelain double shed insulators of the Cordeaux pattern. Copper wire is extensively used. Among telegraph works approved, but not yet executed, the Pneumatic Tube Service for Cape Town is noticeable. This will probably be the only instance of such a service in a British possession outside the United Kingdom, and reveals the extreme keenness of the authorities at the Cape to be abreast of modern progress.

An important line was completed between Cape Town and Durban for the use of the Eastern Telegraph Company. The distance is nearly eleven hundred miles, and the line is worked by syphon recorders. From experiments made by Dr. A. Muirhead, the working of long land lines by this method promises to be highly successful. The present distance is probably the longest for overhead transmission which has been thus far dealt with. The circuits in Cape Colony and adjoining provinces employing quadruplex and duplex systems, have been recently extended. The Wheatstone Automatic System is used with Kimberley, Port Elizabeth, Bloemfontein, Johannesburg, Pretoria, and other places; and it is thought, with the exception perhaps of India, to comprise a larger net-work of wires worked at high speed than any other British possession can show. Repairs to this apparatus and others are carried out in departmental workshops under skilled mechanicians. The post offices at Cape Town and Kimberley are electrically lighted, and at the former there are also electrically

operated lifts. In the various offices there are in use over twenty thousand Leclanché cells, twelve thousand Daniells, and three thousand Bichromates. In regard to telephones the increase of revenue was from £28,000 in 1902, to £36,000 in 1903. The systems used are those of Ericsson, arranged for ringing through. There is an intention of trying the Central Battery system when the time arrives for remodelling any of the larger exchanges of the Colony. There are 1,173 subscribers in Cape Town, 526 at Port Elizabeth, and smaller numbers at a few other places. The circuits include 1,172 miles of wire underground in dry core cables drawn into iron pipes, and total 4,339 miles. The total number of telephones in use on Government lines are nearly four thousand, worked by either Leclanché or dry cells. It is proposed in Cape Town to have a new switchboard for 10,000 lines which would be fixed in a new building. It is of interest to note that a duplex compressor by Reavell of Ipswich, worked by a British Thomson Houston motor is in use for dry air pumping through paper cables, and is very useful.

Trunk telephone lines to Johannesburg, Kimberley, Port Elizabeth, and other places are in contemplation. It is proposed to use copper overhead wires weighing four hundred pounds per mile. Conversation through a smaller wire between Cape Town and De Aar, 500 miles, has already been held as an experiment, but being, it is presumed, earthed, the circuit conditions were not good, and the results only imperfect. Negotiations are proceeding with Lloyds' Committee for the establishment of wireless telegraph stations on Dussen, Robben, and Bird Islands. It will be seen that the record of progress in Cape Colony of the telegraph and the telephone is a highly gratifying one, and shows evidence of the admirable management that has characterised the department.

In the neighbouring Colony of Natal the work of extension is rapidly going on, although telegrams in 1903 were less in number than those of 1902, namely, a little over two and a half millions against three millions. In the latter year, however, the military necessities caused an abnormal amount of traffic. Natal realises £70,000 yearly from its telegrams, and in 1903, there were two hundred offices open, an increase of fourteen over the number for 1902. Mileage of line has increased from 1,598 to 1,722, and of wire from 4,341 to 4,677. It is interesting to note that recording instruments have been abolished and sounders have been substituted throughout the Colony, thus saving in capital cost and maintenance. Wooden poles are being discarded in favour of iron, the taper pole being favoured. The Electric Train Staff instruments were fitted in nine stations in the year 1903, and Sykes' Block signalling apparatus was established in cabins between Durban and South Coast Junction and Durban and Grayville. Nine new telegraph lines were erected in 1903, and six new wires added on existing posts. A fire-alarm system for Government offices in Pietermaritzburg is under consideration. Upon improvements in telephones the sum of £6,329 was spent, and the miles of wire extended from 401 to 586. Some of this consists of underground paper cable. There are also 154 miles of private wire. In Maritzberg metallic circuits have taken the place of single lines and accommodation at the Exchange for 800 subscribers is to be provided instead of 400 as previously. Exchanges have been opened in Ladysmith with sixty-seven circuits, and in Dundee, with fifty circuits. A trunk line between Durban and Pietermaritzburg, will probably be erected this year. Telephone revenue amounts to £3,451, an increase of £996 over the previous year.

Coming to the Transvaal, and omitting the Orange River Colony from which no report has been received in England, there are circumstances connected with the telegraphs which require special mention. The transfer from the Military Authorities to the Post Office took place in August 1902. The conditions of things after the war may be imagined. All lines were in a very bad state, and apparatus seriously out of order. Repairs had been effected with anything that came to hand, even barbed wire being put in circuit with copper. When new stores were ordered there was first the delay in manufacture in England, for telegraph material is not often stocked, then the delay in shipment, and finally, the long period occupied in transport up-country. Again, native labour was scarce. The whole work of reconstruction was carried out under specially trying conditions. The iron poles used are of Siemens' and Bullers' taper pattern, and the insulators of white porcelain double shed, with screwed spindles. Oak arms carrying four insulators each, are largely used with the iron poles. The chief telegraph officer who has supervised all these arrangements is Mr. Hardaker, formerly in the Natal service. The material, it is pleasant to reflect, is of British make, except telephones and their switchboards. The result of the splendid work of the Telegraph Department is that, since the date of transfer, the mileage of line has been increased from 1,444 to 2,085, and of wire from 6,587 to 7,827, the expenditure for repairs and construction (with those of telephones) being £160,000. The Military Authorities were paid £53,000 for line stores and materials transferred. With the circuits thus

reconstituted, including four wires to Cape Colony, four to Natal, and two to the Orange River Colony taken over, there were dealt with one and a quarter million sent telegrams, and two millions of transit and received telegrams. There were also 16,000 telegraph money orders of the value of £98,500. The net telegraph revenue was £88,771. Mr. Chamberlain's visit, as in Cape Colony, required a special travelling staff, *viâ* Potchefstroom, Lichtenburg, and Ottosworp. During this tour the Wheatstone's Automatic System was used, and dealt with 150,000 words for the newspapers. The special correspondents concerned have expressed their high appreciations of the manner in which the telegraphic intelligence was conveyed. Referring now to telephone work, an equally marked increase is exhibited. It is chiefly in evidence in Johannesburg and Pretoria, the mileage of lines being 158 in 1902 and 176 in 1903, private wires 99 and 200 respectively, and instruments 926 and 1,182. The latter are Ericsson's. A trunk line exists between the two towns above named. It is astonishing to learn that at times there are 20,000 calls in one day at the Johannesburg Exchange, and circumstances will probably demand much more extensive arrangements than at present exist. The telephone revenue is at present £18,080 for the whole Colony.

Rhodesia is already well furnished with telegraphic communications, thanks to the stimulus in this direction afforded by the late Mr. Rhodes. Although commercial depression has recently prevailed, still the extension of the lines is going on, and the substitution of iron for wooden poles, in some parts. Among other lines proceeding is that from Buluwayo to the Victoria Falls. It must be well realised by now that the Falls will one day be the seat of vast factories such as are now grouped around Niagara, and their products will be a source of great wealth to South Africa. A line of six copper wires has also been erected from Buluwayo to Heany Junction, and of four iron wires thence to Gwelo, for postal and railway purposes. An iron pole line was put up last year from Palapye Station to Serowe, thirty-three miles in length, and affords communication with Chief Khama. The section of the African Trans-Continental Telegraph Line from Umtali to Tete on the Zambesi River, 249 miles, is controlled by the Rhodesian authorities. This was free from interruptions during the year under report. The telegraph revenue is £28,753, which is less than that of 1902, the decrease being attributed to the quiet state of commerce. The number of telegrams dealt with was 185,000. There are 2,241 miles of poles, and 5,065 miles of wire in existence, both numbers showing an increase over 1902. For telephonic purposes there are 155 miles of line for the police, and 83 for exchanges and private use, with 308 miles of wire. Here again, preference is shown for Ericsson's instruments. Of these there are 283 in use mostly in Buluwayo, and the rent accruing is £3,963. In these respects the languid state of trade has caused a decrease. There are about six calls daily per subscriber in the chief settlements. It is observed, in the annual report, that the rate for a telephone is less in Rhodesia than in the Transvaal. Metallic circuits are contemplated, but financial considerations require postponement of the change for the present.

A brief notice must suffice for the work of the Central South African Railways which have a Telegraph Superintendent of their own. The report deals only with the last half year of 1903. Tyers' Single Line Block System was introduced between Germiston and Witbank. Failures were at first numerous, but improvements have been effected. The same apparatus is in course of being established between Norval's Point and Vereenigig and thence to Miran, and from Pretoria to Komati Poort. Webb and Thompson's Train Staff System has been installed between Standerton and Miran, and at crossings on the South-East line. Extensions in various sections of Siemens' Double Line Block System have been carried out. Telegraphic communication has been free from serious interruptions. It is thought that a stouter class of pole will be required for the large number of wires carried. Lines have been erected from Klerksdorp to Vaal River, Springfontein to Jagersfontein, Springs to Nooitgedacht, and in other places. During the half-year nearly four million telegrams on railway and other services were carried: the value being nearly a quarter-million sterling. There are 179 offices on the system. This review of the telegraphs and telephones leaves no doubt that the authorities are neglecting no means to provide for the public needs and there is no question but that there will be very considerable extensions when the normal state of trade is re-established, and it would not be surprising if, in another year, the promise of a large business in South Africa were realised. The thanks of the writer are due to the Agents General for the Cape and Natal, to the Colonial Office, and to the British South Africa Company, for information kindly supplied.

A System of Sound Telegraphy without Batteries.

By M. G. WAGGOTT.

OWING to the development of the telephones a considerable falling off in the revenue from the telegraphs has taken place. Possibly something might be done to meet this, by doing away with much of the complicated apparatus and circuits which have hitherto been found necessary, by introducing a system of sound telegraphy without batteries. The following description of such a system may be of interest at the present time. The transmitting portion is very simple. It is composed of a key with an iron armature attached to the back of it, a horse-shoe magnet with polepieces and coils, as shown in Fig. 1. The receiving instrument is a sensitive telephone receiver similar to those used by operators in telephone exchanges. The above in combination with a simple form of concentrating switch. Fig. 2 would seem to be a step in the direction of getting rid of complications and costly apparatus. The principle underlying the

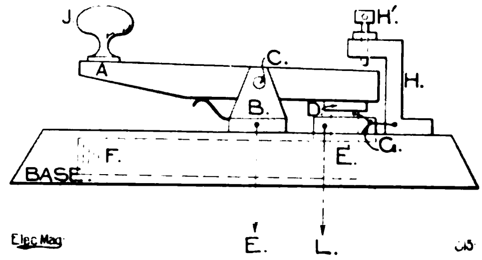
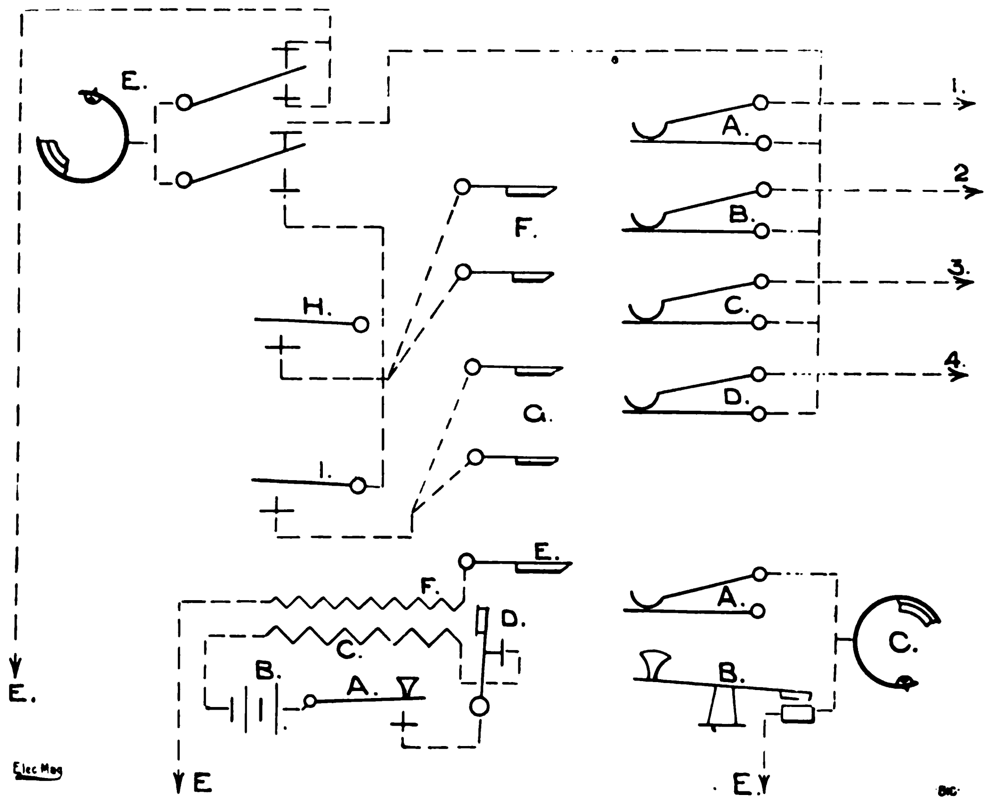


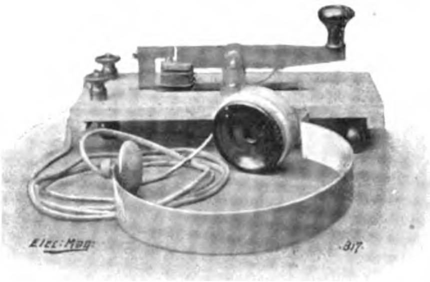
FIG. 1.

transmitter is not new, it is as old as that of the telephone itself. The application of the idea, however, to sound telegraphy I believe to be quite novel. The following is a detailed description of the transmitter, and concentrating switch.

Fig. 1 is the transmitting portion, and is composed of a brass lever A supported on a brass cock B by a steel pin C the lever being left free to move (as in a simple telegraph key). D is an iron armature fixed to the back end of lever A, this armature normally rests on the two polepieces E of the magnet F ; G is the coils surrounding



FIGS. 2, 3, 4.



COMPLETE SOUND TELEGRAPH APPARATUS.

the polepieces, E. H is a brass cock with a platinum pointed screw fitted at I, this screw being used to limit the play of lever A, and also for making the circuit when the lever A has been depressed. J is a knob for manipulating the lever A. A platinum contact is also fitted to one of the polepieces so that the circuit may be completed when the lever A returns to the normal position, a spring being provided to press it back. At K the making and breaking of the circuit by the manipulation of the lever A produces currents in the coils of the receiver which give sharp and clear effects on its diaphragm. The switch, Fig. 2, is composed of a series of switch springs A, B, C, and D, the top springs being joined to circuits 1, 2, 3, and 4. The bottom springs are grouped and joined to the operators set at E and should any of the circuits be calling, their signals would be received on the operator's instrument. Loops are provided at F and G to enable the operator to switch circuits 1, 2, 3, and 4 through to each other. Tapping keys are also provided at H and I, to enable the operator to find out if circuits are disengaged after having been switched through. A double key is also provided at the operator's set E to assist in the tapping arrangement. Instrument springs are fitted to the switch to enable any of the circuits 1, 2, 3, and 4 to send or receive messages to or from the central office. Fig. 3 is a representation of the central office circuit, A the switch spring, B the transmitter, and C the receiver. For the signalling of the outlying circuits an induction coil with vibrator is provided. Key A, Fig. 4, is to join the battery B through the primary coil C, when depressed this causing the vibrator D to act. Should the switch peg E which is joined to the secondary coil F, of the induction coil be inserted into any of the switch springs a sound would be produced in the receiving instruments at the other end of the circuit thus giving a distinct signal to attend. It will be seen from the foregoing, that we have an instrument capable of transmitting electrical impulses by simply depressing and releasing the lever A, the iron armature D fixed to the back end of the lever being the means of disturbing the magnetic lines of force surrounding the coils G and the polepieces E of the magnet. This, together with the simple switch for concentrating the circuits would seem to give promise of some usefulness in the future.

TELEGRAPH NOTES.

The Telegraph in Siberia.

AN interesting account of telegraphy in Siberia is given in the *Electrical Review* of New York. There are two lines from Port Arthur to the Baikal, then three to Irkutsk, four to Omsk, and six to the Urals, and so on to the Russian system to the capital. Installed originally by Danish capital with Scandinavian operators throughout, the system is now controlled by the Russian Government and the old employees have left. The Hughes, Morse, and Wheatstone instruments are used, and there are some by Bréguet.

Difficulties of the Repairing Parties in Siberia.

LIFE among the long-distance line repair men in eastern and central Siberia has many harsh and many pleasant features. Having frequently, during travels, come across their isolated equipments in the "ciepa" or table-land elevations of the Abloni and Altai ranges, and been pressed to put up with them—(such is human nature's craving for a little society)—the writer had happy reminiscences of the outdoor life of those who maintain in repair the overland Siberian telegraph lines.

The little repair companies consist of six or eight men, including the leader "natchalnik." They leave the far-away towns—where they have been wintering—about the middle of April. In winter, the lines are left to shift for themselves pretty much. The climatic conditions are too severe to send parties out, and it is only a very serious or total break which warrants the administration despatching trouble-men to the scene—and then only in parties of two, who hastily make merely the most urgent temporary or makeshift renewals, and beat a speedy retreat. I will leave the reader to imagine repairing "up aloft" in forty degrees below zero, amid the howling icy blasts of the Siberian sub-arctic zone. Also have I come across these solitary mid-winter repairmen in the heart of western Siberia. There they were, half-perished, working in sixty-two degrees below zero, almost frozen, despite their cumbrous and weighty furskin overcoats, which seriously impede their movements. Some of these coats weigh a quarter hundredweight.

Then, to ameliorate conditions somewhat, they build wood-fires about the site where they are working. This tempers appreciably the terror of those arcticky tornadoes of the great "cten" (pronounced ctep) region. To give you an idea of the "searching" character of those Siberian sizzing midwinter blasts, I will state that it will penetrate here and there the dozen eyelet holes of the laced-up boots, and nip with frost-bites the thick wool-encased instep.

But in summer, "the order changeth," and

we get a few months of piping hot, torrid weather. May and June are the evenest tempered months. The repair parties are sent out with their horses and waggons, with tent and provisions; and they also count upon some sport to secure game. They will have, say, 600 verstas of line to cover, and will be at it all summer.

The Life of the Telegraph Lineman in Siberia has its Comforts.

TAKING all things very easy, the Siberian repairmen are through with the day's work by 4 P.M.—by which time one of the men has prepared the dinner for all. Next follows the tea drinking, sometimes coffee, sweetmeats, cigarettes, and then each man has a few hours for himself. They turn in by nine, and the first man is up by three to prepare the coffee. By four all are about, and the sun in those latitudes is well up also, beaming from mountain to mountain. Those early mornings are dry, cool, and clear, with a rising breeze, and the beautiful panorama and mesa foliage on every hand is charmed with all the poetry and imagery of distant prospects and vast horizons.

There is Considerable Delay in Transmitting Telegrams.

EVEN in peace times it was found by actual experience, the Siberian telegraph is unsatisfactory. Thus, wiring from the Ural Mountains back to the Russian Pacific coast (passport trouble), it took nine days to get a prepaid official reply. An express train could have carried the message there and back in ten days. There are two rates, simple and express. If express or double rates are paid, the message takes precedence over ordinary telegrams, but is still preceded (and maybe held up for days) by official routine despatches of mostly no consequence. On the great 5,000-mile caravan route, it frequently happened that an ordinary despatch sent in the morning to the next station, thirty verstas ahead, to announce an arrival (after going over the work) that evening, never turned up till two or three days later—the wires being surcharged by their official use. The writer has not seen much use made of wireless systems in Siberia.

Telephones in Colombo.

THE telephone is becoming more extensively used in Colombo since the metallic circuits were completed. The number of instruments in use has risen from 228 in 1902 to 250 in 1903, and the wire mileage from 308 to 354 miles. Copper and bronze wires are chiefly employed, but the streets in the town are so narrow in the vicinity of the post office, that the Superintendent of Telegraphs finds great difficulty in extending the Exchange system with overhead wires. Probably overhead cables would relieve the congestion were they employed for the more distant subscribers. A scheme of some sort is under consideration. The same official considers that the charges are too high to expect any development among occupiers of private bungalows. The number of calls at the Exchange increased by 68 per cent. in 1903, and the number of complaints decreased from 486 to 332, which is a proof of the growing efficiency of the service.

Notes on the Electrolytic Detector and the Liquid Baretter.

By L. H. WALTER, M.A., A.M.Inst.C.E., A.M.I.E.E.

THE campaign of wireless advertising is now so acute, and the centre of interest—the detector, consisting of a cell with electrodes dipping into an electrolyte—being shortly to be traced to its legal originator, it seems of interest to review the principal points of the numerous family of such devices, which has sprung up of late with such rapidity, even at the risk of the information being stale matter to those who make a special study of the subject. The question of priority, as far as patents are concerned, will not be touched in any way, and the mere mention of one name before another is not intended to mark historical sequence, as that will be decided elsewhere.

Nowadays, the three detectors of this type which one hears a good deal about are (1) the de Forest electrolytic detector (2) the Schloemilch polarisation-cell detector, and (3) the Fessenden liquid baretter, and these are constantly being thrust forward by the commercial side of the wireless interests concerned, and dished up again and again to an expectant public, not yet acclimatised as to what to expect or what to reject in this comparatively new science. The daily Press reports a wonderful long-distance feat, say, and caps it by saying it was X's receiver, which will only notice X's waves, which rendered such a feat possible. Immediately up jumps Y and says that Y's receiver will do quite as much (as might be expected, seeing they are *very* near relatives), and that X's waves are quite able to make an impression on Y's receiver. Z remains silent, perhaps, but that is no indication that Z's apparatus is not equal, if not superior, to X's and Y's.—To resume. The de Forest detector as now used is quite a different apparatus to the electrolytic device which was used in the early days of the de Forest-Smythe system. In the early one the action was of the anti-coherer type, that is, the effect of the waves was to cause an *increase* of resistance. A current was continuously passing, and the waves acted so as to break the circuit normally completed by a number of small metallic chains in the semi-solid electrolyte, the chains re-establishing themselves on the waves ceasing. The action was therefore also self-recovering, and the battery in the local circuit served as a polarising battery, the same as is now employed with the liquid electrolyte form. The new detector, as far as the scant details available show, is

of the polarisation-cell type, there being two fine (platinum) wires immersed in a solution of caustic potash. What is not said, but is necessary to the efficient action, is that the wires, or one at least, must be of very small area, and, further, a polarising battery must be used, unless a wire of another metal has now been substituted for one of the platinum wires. The effect of the waves, though also not directly stated, is to allow a greater current to pass through the cell than that which normally is continually flowing, the current returning to its normal value on the waves ceasing. This self-restoring property has several times been dilated upon as being peculiar to the de Forest device, but it is shared by all the other members of the family and is also a property of most magnetic receivers as well as of some coherers. Good results have undoubtedly been obtained with this detector, but then the transmitter plant usually consists of a two-kilowatt generating set, so that the power provided is considerably greater than that generally used by others. This is of some importance, for the land station near Wei-hai-wei, for communicating with the *Times* despatch boat *Haimun*, is pointed out in several papers as being able to signal 100 miles and over, while the British torpedo-boats' apparatus there have a range of only forty-five miles about. Here, again, it is omitted to state that the torpedo-boat installations are worked with dry batteries giving at most 300 watts, and, further, these Marconi installations are of the old type. No comparison should have been made under such circumstances.

Coming now to the Schloemilch detector, this is also of the polarisation-cell type and, furthermore, of the rectifying type. More details are to hand regarding this detector, the original paper by Schloemilch in the *Electrotechnische Zeitschrift* being liberal in this respect. This detector has been adopted by the Gesellschaft für Drahtlose Telegraphie (controlling the Braun and the Slaby-Arco systems), which has comparatively recently followed the modern tendency to discard coherer-type receivers for the more definite current-actuated, self-restoring ones. One electrode in this cell is of platinum, and may be of any size, while the other is of exceedingly small dimensions ($\frac{1}{1000}$ millimetre in diameter and $\frac{1}{100}$ millimetre long), and is either of platinum or can be made of lamp-filament carbon. The electrolyte used is dilute acid (sulphuric), and a polarising battery, of E.M.F. slightly higher than the counter-E.M.F. of the cell, is so connected that the diminutive electrode is the anode. There is a certain best value for the E.M.F. of this battery and for the normal current through the cell, only a very moderate gassing being permissible; above this value the sensitiveness falls off very quickly. In place of two electrodes of the same metal the larger electrode can be made of a different metal and so provide its own polarising E.M.F., thus doing away with the necessity for a separate battery, but the sensitiveness is considerably inferior to that obtainable by the first method.

Turning next to the Fessenden liquid baretter, there appears to be a certain amount of misconception about this receiver, owing to the fact that Professor Fessenden has also patented an electrolytic detector in which, according to him, the action is due to rectification of the waves, and the action taken by him against the de Forest Co. is based upon an alleged infringement of this electrolytic detector. The liquid baretter is claimed by the inventor to be a receiver acting by purely thermal means, and consists in principle of an electrolyte into which two fine platinum wire electrodes dip. A number of ways of constructing such a liquid baretter are indicated in the patent specification. It is stated that if the loop of a platinum loop baretter be broken, it acts more efficiently than before (if the ends are dipped into the electrolyte), and consequently a baretter in its simplest form can be made by merely dipping two fine platinum wires into the acid. A loop of moistened fibre having one end dipping into the liquid is another form of construction. Of the more refined type is one in which a minute hole is formed through a diaphragm, which can be done by drawing out a capillary tube to about $\frac{3}{1000}$ in. diameter and cementing it into a hole in the centre of a thick glass disc and then grinding off the ends of the tube till flush with the surface. The diaphragm forms a division between the upper and lower parts of the electrolyte, the thin column of liquid forming the baretter and the electrodes being placed one in each half. The arrangement adopted in practice is illustrated in Fig. 1. In this a fine platinum wire (12) is only immersed a very short distance into nitric acid. (The wire is composed of a silver wire with platinum core and is drawn out till the silver wire is $\frac{3}{1000}$ in. in diameter and the core $\frac{4}{100000}$ in. in diameter. The silver is eaten off by the acid, exposing the core.) The second electrode (13) is fused into the bottom of the vessel, and the acid has a layer of kerosine on it to prevent evaporation. The fine wire may be surrounded with glass to prevent any gas given off from adhering to the wire and thus decreasing the effective area. Other liquids can be used, such as carbonate of soda, caustic

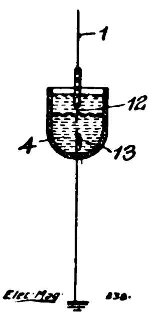


Fig. 1.

soda, and nitrate of potash solutions, and with a high local circuit voltage (7–8 volts) carbonate of soda gives greater effects than nitric acid, but the latter is best with lower voltages.

The effect of the waves is to cause a larger current to flow in the local circuit through the baretter, and with a baretter of resistance 600 ohms the change is said to be sufficient to work a syphon recorder. Professor Fessenden also sums up, in his specification, the various distinct methods of using a metal and liquid to form a receiver for electric waves.

(1) A conducting metal dipping into mercury. There is a coherer action in such a case, and this effect is disclaimed for the baretter, the inventor going to unnecessary lengths to prove that no coherer action takes place. (None would be expected from the junction of the metal and the low-conductivity electrolyte.) Again, the resistance change is said to be exactly proportional to the energy of the waves, thus differing from the coherer; but it has not yet been proved that the electrolytic detector does not possess that property also. And, finally, it is pointed out that if the size of the wire be increased the effect falls off according to theory (but this may be due to other reasons, as will be shown later).

(2) Professor Fessenden then refers to the rectifying electrolytic detector devised by himself, and observes that rectification does not occur with the baretter. This is ascribed to the fact that the baretter absorbs the energy, and so does not let any pass through to be rectified, and also because the polarisation capacity is too small. A third proof of this is considered to be the fact noticed that when both wires consist of similar pieces of platinum the effect is almost the same, when according to theory there should be no rectification.

(3) Another method described consists in utilising the depolarisation of the electrode caused by the heating of the liquid. This it is admitted *does* take place, but is held to be masked by the change-of-resistance effect.

(4) Yet another method is available if the local battery p.d. is raised so that very free gassing takes place. Under these conditions the waves cause an *increase* of resistance, considered to be due to deposition of bubbles of gas on the wire diminishing the area of contact. This action is stated to be only irregular, and to occur at a critical point only.

It is finally pointed out that the baretter will work well whichever pole of the local battery is connected to the small electrode, but that better results are obtained when this is made negative—probably owing to bubbles of gas coming off being dissolved in the liquid and maintaining the conductivity. It, of course, seems hardly necessary to state that one electrode (immaterial which) of the detector is connected to the aerial and the other to earth for the ordinary direct (Marconi) method. In the next issue it is proposed to describe other electrolytic detectors and work by other investigators on these, which will show that some of the current statements are not quite in accord with the facts.

(*To be continued.*)

Stone Wireless Telegraph Patents.

PROF. STONE is known over here as a prolific inventor, but one was hardly prepared for the huge batch of patents such as was recently published in the United States. No fewer than thirty-six patents on wireless telegraphy are issued to Prof. Stone under date of August 16, 1904, and these contain 547 claims. It is quite impossible, and in fact unnecessary, to deal with all of these as a large number only relate to details, but not a few possess considerable interest owing to the litigation they will probably give rise to eventually. One of the earlier more characteristic applications relates to the simultaneous transmission and reception of messages, which is already known in principle as one of the distinctive devices of the Stone system. In Fig. 1 a diagrammatic representation of this method is shown. It consists of a vertical aerial V, in the same plane as two other aerials V′ V″, equidistant from the first. The aerial V is used for transmitting, during which the effect of the oscillations in it is to induce oscillations equal in amplitude and phase in the other two aerials; and these are caused to oppose one another in the receiver, so that no signals are produced in the receiver from wave emissions from the local station. Several other patents relate to the use of the bolometer as a receiving device. Wonders never cease, but one would have thought that the work of Rubens and Arons, as well as that of Fessenden, in the latter case with actual wireless telegraph apparatus, would have prevented any possible patent of any scope being granted on a bridge form of bolometer.

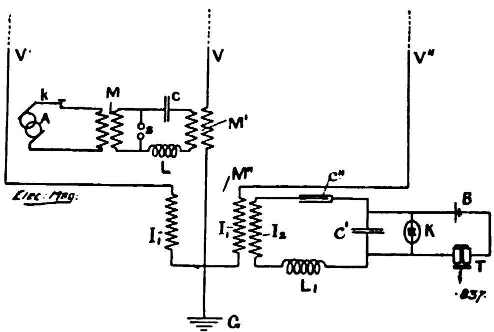


FIG. 1.

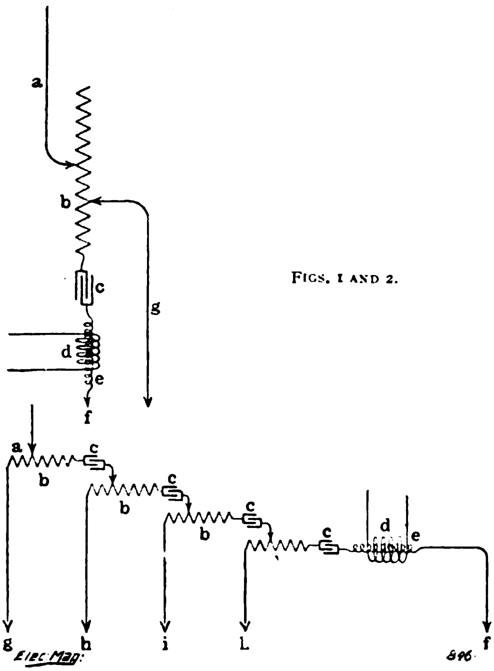
Three further patents deal with a substitute for the high aerial wire, consisting in the use of a large circular metallic plate supported above and parallel to the earth and connected at its centre to a short aerial which is earthed as usual. Here again the similarity to the method proposed by Blondel is very striking, and Blondel published his method before Stone's application was filed. Two other patents refer to the use of thermo-electric couples as detectors for wireless telegraphy, and the claims are of such a comprehensive nature that it would appear as if even the Duddell thermo-galvanometer would come within their range. On the other hand, a patent on the use of a multiple spark-gap in compressed air appears to be a rather tardy recognition of the advantages of this kind of spark-gap, which had already been made use of by Jervis Smith and Fessenden. In the same way, one of the methods proposed for increasing the amount of radiated energy, consisting in providing a conducting network laid upon the ground round the antenna and of radius $\frac{1}{4}\lambda$, reminds one to some extent of the method adopted in the Lodge-Muirhead system for military telegraphy, and to a less extent of the wave-chute of Fessenden.

Among the more recently filed of the patents there are others dealing with receivers of the nature of the electrolytic cell. One describes a cell containing a very fine wire positive terminal, the action being purely electrolytic, whilst two others describe forms of construction by which the thermal effects produced in the fine wire electrode are localised, after the manner of the Fessenden baretter.

In conclusion, Prof. Stone is to be congratulated on having given to the world yet another record, and on the ingenuity displayed in the numerous new and useful devices suggested. It is to be hoped that as regards the rest that our fears will prove to be groundless.

SYNTONIC WIRELESS TELEGRAPHY.

A RECENT patent of Signor Marconi's, printed in full in the *Electrician*, is entitled "Improvements in Wireless Telegraphy." The arrangement adopted is for the purpose of obtaining syntonic effects and for the minimising of disturbances due to atmospheric electrical phenomena. One form is shown in Fig. 1, where *a* is the antenna end, *b* the syntonising inductance, and *c* the fixed capacity, *d* being the magnetic detector or any other suitable detector, one terminal *e* of which is grounded at *f*. It is found that an additional ground connection *g* when slid along the inductance *b* will give signals on the detector from waves of a



FIGS. 1 AND 2.

particular, chosen frequency to the exclusion of waves of other frequencies from other stations. The best position for the contact on *b* is found to be where there is a potential node or point of zero potential of the wave of the chosen frequency. A different arrangement is shown in Fig. 2, in which a series of similar tuned circuits are grounded at the points *g*, *h*, *i*, *k*, and *f*, which are determined by the chosen periodicity. This latter arrangement is found, it is said, to give very sharp tuning and to be particularly effective in eliminating atmospheric disturbances. It must be borne in mind that the Slaby-Arco system has long employed a second ground connection for shunting-off waves of undesired frequencies, but the arrangement is somewhat different.

WIRELESS TELEGRAPHY AT THE ST. LOUIS EXPOSITION.

AMONG the wireless telegraph exhibits at the World's Fair that of the American de Forest Company is said to be attracting great attention. No fewer than ten sets of instruments are fitted up within the exhibition precincts, in seven different stations. Two sets are in operation in the Government building, displayed by the United States Signal Corps, and the working of these is explained to the public at intervals, this feature drawing large attendances. The "Observation Tower," 300 ft. high, is used as a transmitting station, and it is said that 3,000 to 5,000 words are trans-

mitted daily to newspaper offices, the rate of transmission being reported as from twenty-five to thirty-five words per minute. The plant used was described in one of our earlier issues. There are also two stations in the Electricity Building, one in connection with the Fort Wayne exhibit and the other in the de Forest booth. The aerial wires are hung from three slender, wooden towers, 75 ft. high, in three harps of converging wires. Current is taken from the mains at 110 volts 60 ∽, and is transformed up in a 2-k.w. transformer, the secondary being connected to eighteen Leyden jars, of 0.013 microfarad capacity and the syntonising inductance, both of which latter can be seen in the figure. Two different wave-lengths are used, one for receiving from the Fort Wayne exhibit, only 400 ft. away, and the other for receiving from the long-distance station, situated on Art Hill, about half a mile off. The Art Hill station has the aerial wires hung from a 40-ft. cross-arm at a height of 210 ft., and the wires, twenty in number, are about 250 ft. long and are spread out by cord-spreaders. These wires enter the building, in two bunches of ten wires each, through the roof, and are used for transmitting, the receiving antennæ being quite separate in a building near the foot of the mast. The earth connection consists of 140 sq. ft. of copper plate buried 8 ft. below the surface, means being provided for keeping the earth in a damp condition. Messages have regularly, it is understood, been sent and received at Springfield, Illinois, 105 miles distant, and according to the latest information in the *Electrical World and Engineer* the service between the above long-distance station and Chicago, 300 miles distant, has been successfully inaugurated, the accurate reception of the messages being vouched for by Mr. W. E. Goldsborough, the chief of the department of electricity of the St. Louis Exhibition.

WIRELESS TELEGRAPH NOTES.

Wireless on the Pacific Coast.

ACCORDING to the *Electrical World and Engineer*, the Pacific Coast Steamship Company is installing wireless telegraph apparatus on the steamers *Queen*, *Amatilla*, and *City of Pueblo*, plying between San Francisco and the ports on Puget Sound. These installations will be put into operation as soon as the land station on Tatoosh Island is ready.

Electro-Mechanical Syntonic System.

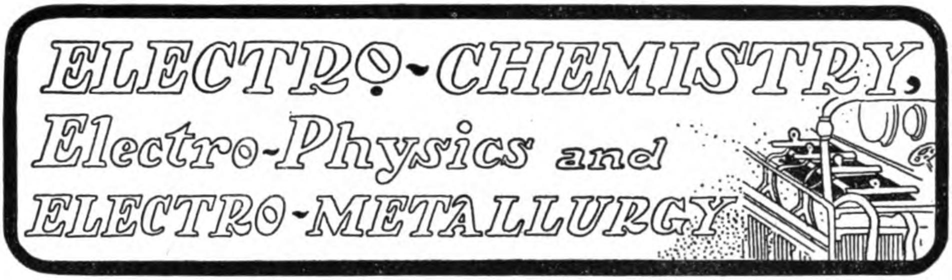
A PATENT on an electro-mechanical syntonic wireless signalling system has recently been issued to Prof. M. T. Pupin. In this, a telephone receiver has its disc adjusted to have a definite period of mechanical vibration so that magnetic impulses received at intervals corresponding to this period will the most easily produce a sound in the receiver. The impulses are produced by adjusting the spark-gap so that discharge across it only takes place at the maximum value of the voltage obtained from an alternator. The oscillations set up will affect the receiver only when the speed of the alternator corresponds to the mechanical vibration period of the disc. The impulses are interrupted, by means of a telegraph key in the alternator circuit, for various lengths of time, thus rendering the signals intelligible.

A Crusher for Wireless.

FOR a long time past there have been negotiations regarding the installation of a wireless telegraphic service between Denmark and Iceland, as, owing to the volcanic nature of the latter island, the cost of cable repairs, it was expected, would form a heavy item of expenditure. The Marconi Company seemed well in the running, and the intermediate station which was to be erected on the Shetland Isles was looked upon as affording opportunities for wireless communication with other parts. The Danish Government has, however, now decided to lay cables, *viâ* the Shetlands, so that it is probable that nothing will come of the wireless scheme. It would be interesting to know whether the wireless method of communication is held not to be sufficiently advanced or reliable, that the much greater expenditure necessitated by the adoption of wire telegraphy is contemplated, or whether it is a case of too grasping demands being made by the wireless people. Possibly, the absolute monopoly and the long-period contract had something to do with the matter.

The Telemobiloscope.

THIS is the name of an apparatus just brought out by Mr. Hülsmeyer, of Düsseldorf, Germany, and demonstrated a short time ago before representatives of the North German Lloyd. The new invention is based on the principle of wireless telegraphy, and is intended for viewing ships and metallic objects on the sea. The distinctive feature between existing applications of wireless telegraphy and this invention is, however, apart from constructive details, the fact that whereas in wireless telegraphy the transmitter and receiver are used separately on different ships, they are both arranged on the same ship in the telemobiloscope. The electric waves emitted from the sender not being able to reach directly, the receiver must be reflected by metallic objects on the sea (that is, ships), so as to arrive at the receiver on a broken path. The advantage afforded by the invention is mainly that ships fitted with the transmitter and receiver will be able to view any other ship devoid of these apparatus. It will even be possible to inform the captain on the bridge in the case of distances ranging between three and five kilometres of the position of an approaching ship, to enable him when luminous and fog signals fail to alter his vessel on the right course, so as to avoid accidents in time. Experiments so far made on small instruments designed for shorter distances have given every satisfaction.



Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section at end of Magazine.

The Magnetic Resistance on Air-Gaps.

On account of the course of the flux in the air-gap between two polar surfaces being unknown, the accuracy attainable with many calculations is rather unsatisfactory. Dr. G. Benischke, in a paper published in No. 37 of the *Elektrotechnische Zeitschrift*, records a series of measurements made for the simplest possible case where the flux traverses the air-gap between parallel square polar surfaces, the magnetising coils reaching close up to the latter (the distance of the coils from the pole-surfaces being about 1 cm. and the distance of the iron core from the surrounding coil 2 to 5 mm.) (*see* Fig. 1). Alternate currents were used with these measurements. The total magnetic resistance of the flux is calculated from well-known formulæ, and after deducting the magnetic resistance of the portion traversing the iron cores the magnetic resistance of the air-gap is obtained. The values thus found are represented in terms of the air-gap for different pole-surfaces s in Fig. 2. From these the equivalent cross-section S of the flux in air is found from the formula $w = \frac{\delta}{S}$. S being the cross-section of the flux in the case of its filling the air-gap in parallel lines of uniform density. The curves of Fig. 3 are thus obtained, being approximately straight lines of the shape $S = s + k\delta$, where s is the polar surface (corresponding to $\delta = o$). The values of k in terms of the polar surface s are recorded in Fig. 4. This curve in connection with the above equation allows of the equivalent cross-section S of a beam of lines of force in air being calculated within certain limits of the

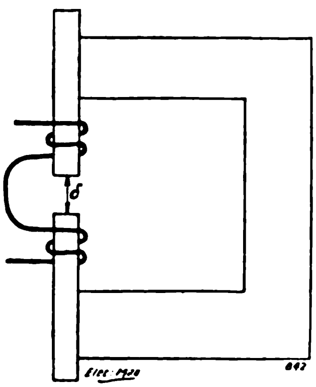


Fig. 1.

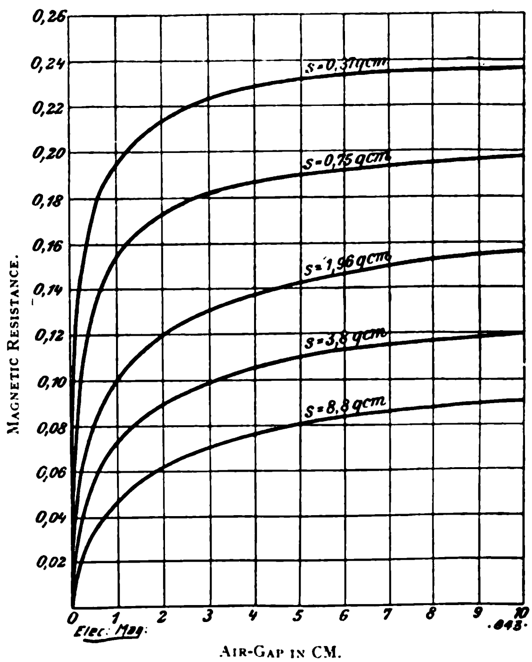
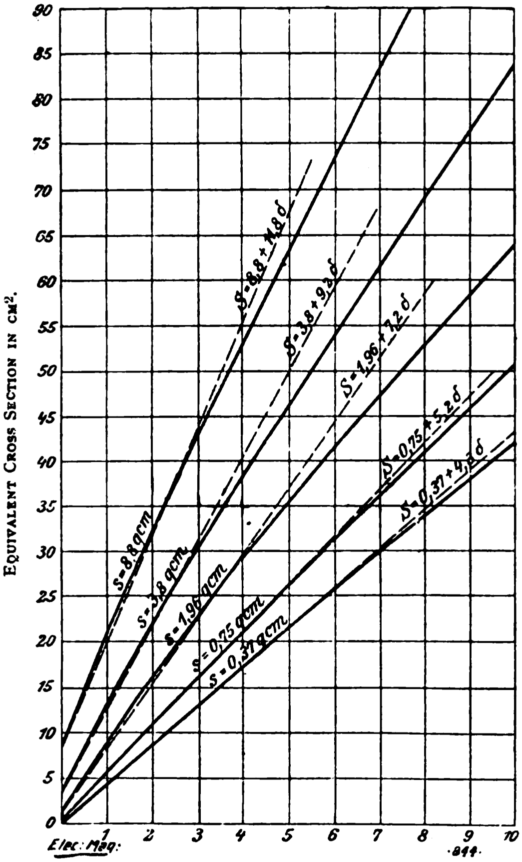


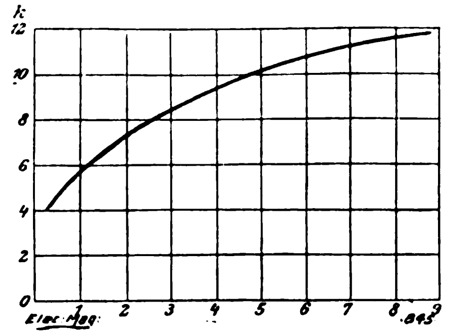
Fig. 2.



Air-Gap in cm.

Fig. 3.

air-gaps and polar surfaces, whereas for higher values of the air-gap and greater or smaller polar surfaces the curve *s* in Fig. 12 will allow of other values being found by convenient interpolation or extrapolation.

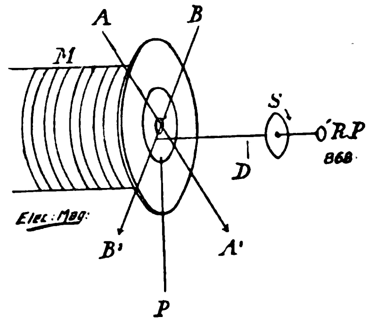


Polar Surface in cm².

Fig. 4.

ROTATION PHENOMENON IN A.C. MAGNETIC FIELDS.

When placing in the field of an alternate current a rod-shaped electromagnet *M* as nearly parallel as possible to the issuing lines of force, and preferentially in a horizontal position, a wire or rod (*see* Fig.) *D* of soft iron so as to approach to the pole *P* without touching the same, while being free to vibrate at the other end *RP*, there will be observed a singular torque, susceptible of being transmitted to other bodies fixed to it in a rotary manner. The most simple scheme according to Mr. H. Axmann, who first observed the phenomena, consists in choosing a disc



of pasteboard (a postcard) *S*, 8 to 10 cm. in diameter, being loose on the iron rod, when, on the circuit being completed, the disc will be found to rotate with a high speed, to the left if the vibrating wire or rod is conveyed at its free end in the direction *A A'*, and to the right if in the direction *B B'*. The speed being zero in the centre *O* will increase towards periphery, to vanish beyond the latter. Similar effects are observed in the case of a sheet of paper being placed conveniently in front of the magnetic pole located horizontally, and spread with very finely divided iron powder, when four small circles will be observed, the inner part of which is void whereas at the periphery all the particles are wandering swiftly in the above indicated direction. The author thinks this phenomenon to be due to the vibrations of the rod *D*, which according to the period of the alternate current would be able to give similar effects with the simultaneous action of gravity. (*Physikalische Zeitschrift.*)

ELECTROLYTIC GALVANISATION.

An inventor, M. Gabran, has recently published the results of experiments undertaken with a view to obtaining rapid deposits of zinc. The best electrolyte for this purpose was found to be constituted as follows:

Zinc sulphate	1,200 parts
Sulphuric acid, 24 B . . .	60 ,,
Water	6,000 ,,

Using current-densities of 2 and 3 amperes per sq. dm., very clear solid deposits were obtained with this liquid, the tension being kept between 1.5 and 2.5 volts. Subsequently this density was increased to 6 amp. per sq. dm., and the voltage to 9 or 10 volts, without in any way influencing the deposit, though crystals of zinc formed on the edges of the cathode. When employing greater current-densities the electrolyte must be kept rapidly circulating. For galvanising large pieces of ironwork, such as plate reservoirs, hulls of ships, &c., M. Gabran has devised an apparatus which unless we are mistaken greatly resembles the one invented by Mr. S. Cowper-Coles for the same purpose, consisting of a large cup-shaped leaden-receiver, with rubber-protected edges, in and out of which the electrolyte is conveyed through piping. The anodes are constituted by zinc cylinders fixed to the bottom of the receiver, which is connected to the positive pole. To use the apparatus, it must be pressed hard against the plate or article to be galvanised, which thus acts as a cover. The rubber ring prevents the electrolyte from escaping. A surface, 0.8 dm. in area, can in this way be coated with zinc, the density used being 80 amperes per sq. dm., and the pressure 50 volts. Seven seconds suffice for one operation, after which the apparatus can be shifted on to a fresh part of the surface. Very probably such a high density must lead to a rapid variation in the composition of the electrolyte, in spite of the zinc anodes. This is why in the Cowper-Coles process the liquid is regenerated by being circulated through a layer of coke- and zinc-dust, the latter dissolving very rapidly in an acid electrolyte. According to the inventor, the apparatus is to be used for galvanising rivet-heads in hulls whose plates have been previously galvanised.

PSYCHICAL AND PHYSIOLOGICAL PHENOMENA AND THE CONDUCTIVITY OF THE HUMAN BODY.

In the course of some investigations into the possible influence of an alternate magnetic field on the electric conductivity of the human body (see *Schweizerische Elektrotechnische Zeitschrift*, No. 20). Mr. E. K. Müller happened to observe some singular variations in this conductivity according to the psychical and physiological condition of the person, the following being borne out:

(1) The magnitude of the resistance is dependent on the hour of the day, where the measurements are made, and further to a great extent on the kind of food taken.

(2) A striking fact is the singularly frequent return of exactly identical figures in series of experiments lasting for ten to fifteen minutes, in the same minutes with the same person even in the case of the experiments being separated by several days.

(3) The question whether the person experimented on is isolated in a special room or else in the company of a third person has a great bearing on the figures found as well as on the regularity in the course of the numeric series. Whenever a newcomer enters the room or a noise is produced the resistance is found to be altered spontaneously to an extraordinary extent.

(4) Not only objective causes but any internal or outside psychical influence will result immediately in an oscillation (of an often enormous magnitude) in the figures found for the resistance. Any sensation or psychical emotion of some strength will reduce instantaneously the resistance of the human body down to a value three to five times less. Whenever the person in question is talked to or caused to concentrate his attention in any way oscillations in the resistance are noted. Any volition, any attempt to hear a distant noise and any effects of self-suggestion show an appreciable action as well as any excitation of the senses, any intensive light ray striking the closed eye, any smelling of bodies even devoid of any smell, or of fictious bodies was further found to be very effective. Any physiological action of some strength, such as breathing, retaining the breath, &c., was found to exert a similar effect. Measurements made at the beginning and during sleep will give evidence of the character of the sleep as well as of the vivacity of dreams.

Any pain either real or suggested will result in an alteration of the resistance, the sensation of pain being preceded by an oscillation (in the case of a real pain) and followed by a second oscillation. The individual resistance of the body is further found to depend on the nervous excitability and the conditions the person is living in. Nervous persons as well as strong smokers and drinkers are found to have an exceedingly low electric resistance. The variability in the temporary behaviour of the resistance during an experiment is also found to depend on these factors. Interesting results were found in some experiments on the influence of hypnose when an extraordinary nervous calmness was stated, which however was interrupted by a sudden increase in the resistance of a strength such as was never observed before in the course of these researches, as soon as the hypnotised person was influenced in any way. As regards the order of magnitude of the resistance, this (as measured from one hand to the other) was found to average

3,000 ohms. As to the question whether these oscillations of the resistance are due to an electric phenomenon (an alteration of the electric conductivity of the nerves or vessels themselves), or else to an alteration in the nervous centres, further experiments will have to be made before this can be decided. A preliminary account of the author's experiments on the influence of alternate magnetic fields on the electric conductivity of the body states an increase of the individual resistance.

ELECTRO-PHYSICAL NOTES.

The Electric Field surrounding Conductors and Electrolytes during the Passage of the Current.

W. Nikolaïff endeavours by means of experiments to show that an electric field the tubes of force of which coincide with current lines exists within an electrolyte. He demonstrates first, the repulsion of bodies charged with electricity of contrary signs; second, their movement on parallel paths; third, the movement of the vessels containing the electrolyte; fourth, a phenomenon to which Prof. E. Cohn drew attention and which consists in the repulsion undergone by mica plates on the path of the electric field. Fifth, the author shows the existence of a particular electric field within a dielectric immersed in electrolytes, this field being independent of the electrolytic field.

Action of Radium on Metals.

According to a foreign contemporary, M. Orloff made a curious discovery in April 1903, in connection with radium. Having covered with an aluminium-plate 1 mm. thick an ebonite beaker containing .03 grms. of radium bromide, he found on uncovering the beaker that several protuberances like drops of molten metal had formed on the surface of the aluminium facing the radium. The general aspect of these, however, remained otherwise similar to the rest of the plate. The protuberances were found to be radio-active, producing a photographic image through black paper after several minutes contact, their emanations appear to last six months without signs of abatement. The author presumes that there is in this case formation of a stable alloy, due to the accumulation around the light aluminium nuclei, of particles proceeding from the atomic systems of the radium.

On the Emanation given off from Radium.

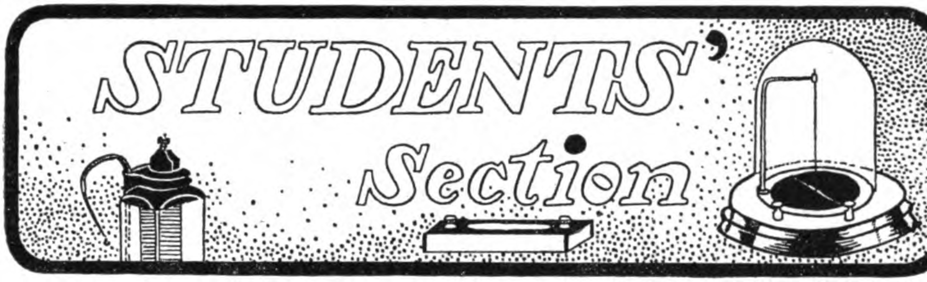
The emanation produced by radium has been frequently investigated, so that many of its properties are known; the question as to whether the particles constituting this emanation are charged or not, seems however not to be definitely solved, though a solution of the same would be necessary for obtaining an adequate idea as to the decomposition of radium atoms. In an article published in No. 17 of the *Physikalische Zeitschrift*, Mr. J. A. McClelland examines as accurately as possible whether the emanation bears an electric charge, as would seem to be the case according to Rutherford's work. It is definitely shown that such is not the case, this being of the greatest bearing on radium theories. As radium atoms are sure to give off positively charged particles (being the alpha-rays) the emanation particles cannot possibly be the remainder of the atom left by one or several alpha-rays, as in that case the emanation should be negatively charged. The atom, therefore, must have given off a negative charge of the same magnitude, either by an emission of negative particles or in any other way.

Permanent Electric Breathing Figures.

A singular kind of so-called electric breathing figures was, according to a notice in No. 17 of the *Physikalische Zeitschrift* produced by Mr. H. Axmann on conveying high-tension electric currents off to glass surfaces. In opposition to the familiar lighting figures, these figures proved permanent. Anyhow, the author possesses some glass plates ten years old, and which in spite of a most thorough cleaning will always again show the old figures on being breathed upon. If observed under the microscope around, drops of water of remarkable smallness are observed at these places, showing sharp boundering outlines and refracting the light in a singular way. By no one of the usual methods was the author able to evidence any alteration in these glass plates. The figures were best produced by connecting one pole of the induction oil (50 cm. explosive distance) with the edge of the glass plates, while the other was in communication with a metallic matrix, lying on the glass, the direction of the pole being of no importance. A soft but not too slight pressure was found to be necessary to produce permanent figures. Soft metals pressed on the plates by means of a spring seem to be quite suitable.

On the Melting Current in Fuses.

In No. 35 of the *Elektrotechnische Zeitschrift*, Mr. E. Oelschläger records some experiments made by him with a view to establishing the behaviour of fuses by oscillographic measurements. It was shown that the fuses investigated would melt with a current ten times higher than the normal current (that is, with 200 amps.) after 0.070 seconds, with a twenty-fold current after 0.016 second, and with a fifty-fold current (1,000 amps.) after 0.004 second. It was further found that with every experiment, nearly independently of the current intensity, about thirty watt-seconds or joules were necessary for melting the wire, the curve of the melting energy in terms of the time of melting being practically a straight line, the highest value observed for the greatest times of melting being forty joules and the smallest thirty joules. These figures correspond fairly well with those calculated directly from the dimensions of the melting wire. In the course of some further experiments a short circuit was produced in the immediate neighbourhood of the accumulator, when the current within 0.0002 second was found to increase up to 5,000 amps., to decrease rapidly again, and after taking a negative value of 3,000 amps. to disappear in a small positive plant. The melting current was thus found to be two hundred and fifty times greater than the normal current.



Students should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles of special interest to them.

Some Illustrations of Approximate Methods of Solving Problems.—V.

By ALFRED HAY, D.Sc., M.I.E.E.

(*Continued from p. 284.*)

Problem of Leaky Telegraph Line.

We have already considered the problem presented by a submarine cable (*see* THE ELEC. MAG., vol. ii. p. 65); and we propose to conclude the present series of illustrations of approximate methods by the study of the commonest form of telegraph circuit—an overhead line.

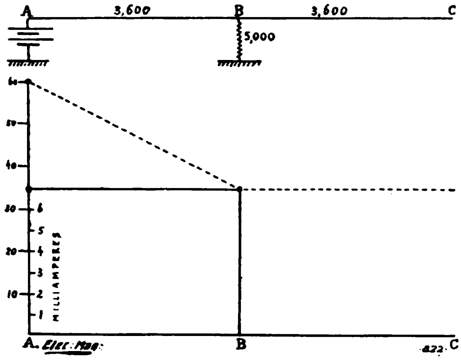
So long as the line is short, the amount of leakage taking place is only a very small fraction of the total current entering the line, and the insulation may be regarded as practically perfect. But as the length of line increases, the number of points at which leakage can take place increases in direct proportion to the length, and at the same time the "conductor resistance" of the line increases in the same proportion (for a given size of wire). In other words, the insulation resistance of a line varies *inversely* as its length, while the conductor resistance varies directly as the length. To take two extreme theoretical cases, we may say that an infinitely *short* line has an infinitely low conductor resistance and an infinitely high insulation resistance; while an infinitely *long* line has an infinitely high conductor resistance and an infinitely low insulation resistance.

It is therefore evident that beyond a certain limit of length the conductor resistance will be a quantity of the same order as the insulation resistance, and hence a very large fraction of the current entering the line at the sending end will leak away without reaching the receiving end. Allowance must be made for this, as otherwise the currents passing through the receiving instrument (generally a relay) would be too feeble to affect it.

We are assuming that the leakage is the normal leakage which occurs at every pole of a sound line, and that the line is free from faults; the insulation resistance of all the insulators is supposed to be equally good, so that the condition of the line is characterised by *uniformity*. Absolute uniformity is, needless to say, an ideal condition unattainable in practice. For not only is it impossible to turn out insulators absolutely identical in every respect, but even if we did succeed in so doing, the condition of a line many hundreds of miles in length would still in general depart from uniformity, owing to the fact that different sections of it pass through countries whose climatic conditions must necessarily be very different, and that the insulation resistance is wonderfully sensitive to the slightest variations in the weather.

Approximate uniformity may, however, be reached; and there are certain tests by means of which the state of a line as regards uniformity or otherwise may be roughly estimated.

It may not be out of place to explain precisely what we mean by the insulation resistance of a line. Imagine *every* point of the line to be maintained, by suitable means (such as batteries distributed at numerous equal intervals), at a steady potential V above the earth—both ends of the line being, of course, insulated. If the total current which leaves the line and flows



FIGS. 19 AND 20.

to earth is i, then the quotient $\frac{V}{i}$ gives us the insulation resistance of the line.

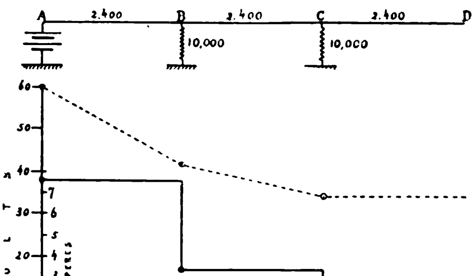
From this it follows at once that if *one end* of a long leaky line be maintained at any potential V' by means of a battery whose other terminal is earthed, the far end of the line being insulated, and if the total current i' entering the line be measured, then the quotient $\frac{V'}{i'}$ does *not* give us the true insulation resistance of the line. For on account of the resistance of the conductor which forms the line, there will be a steady fall of potential along it; hence the leakage currents which leave the line beyond a certain distance from the battery end will be considerably less than they would be had the entire line been maintained at a uniform potential V'. Therefore the quotient $\frac{V'}{i'}$, which we may conveniently speak of as the *measured insulation resistance*, is *greater* than the true insulation resistance of the line.

In order to illustrate this point, we shall consider the following numerical example. A line 800 miles long, has a total conductor resistance of 7,200 ohms, and a total insulation resistance of 5,000 ohms. By means of a battery one of whose terminals is earthed, one end of the line is maintained at a potential of 60 volts, the other end being insulated. The problem is to find the total leakage current entering the line and the value of the "measured insulation resistance"; also to determine the distribution of potential along the line.

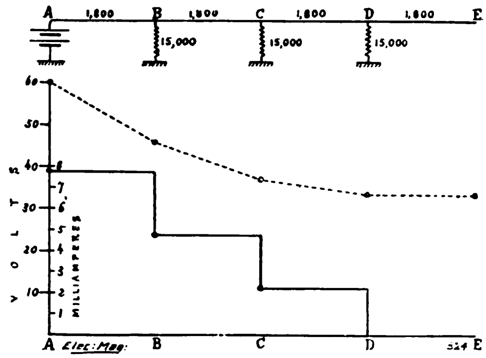
In attacking this problem, we shall follow the method, previously employed in connection with some other problems, of first assuming that the leakage, instead of being distributed along the line, is *concentrated* at its middle point. This arrangement is shown in Fig. 19, where a single leakage path of 5,000 ohms is applied to the middle point B of the line, the insulation of which is otherwise supposed perfect. The value of the current is $\frac{60}{3600 + 5000} = .00698$ ampere, or 6.98 milliamperes. The current has this uniform value in the first half AB of the line, and has a zero value in the remaining half BC. The current distribution may therefore be represented as shown by the full line of Fig. 20. Next, since the resistance of AB is 3,600, and the current in it .00698, the fall of potential along AB is $3600 \times .00698 = 25.13$ volts, and hence the potential of the point B is $60 - 25.13 = 34.87$ volts. The distribution of potential along the line is shown by the dotted line of Fig. 20.

We now proceed to a second approximation, by assuming two leakage paths, each of $2 \times 5000 = 10000$ ohms, to be applied one-third and two-thirds respectively of the way down the line, as shown in Fig. 21. The total resistance from B to earth is the joint resistance of the two parallel paths of 10,000 and $2400 + 10000$; *i.e.*, it amounts to $\frac{10000 \times 12400}{10000 + 12400}$ or 5.535 ohms. Hence the total resistance from A to earth is $2400 + 5535 = 7935$ ohms, and the current entering the line is $\frac{60}{7935} =$ .00756 or 7.56 milliamperes. The drop along AB is thus $2400 \times .00756 = 18.14$ volts, giving for the potential of B $60 - 18.14 = 41.86$ volts, and for the current in BC 3.37 milliamperes. The drop along BC is 8.09 volts, and the potential of C is therefore 33.77 volts. The current and potential diagrams for this case are shown in Fig. 22.

The third approximation, corresponding to Fig. 23, may now be proceeded with. The resistance from C to earth is $\frac{15000 \times 16800}{31800} = 7.923$, the resistance from B to earth $\frac{15000 \times 9723}{24723} = 5900$, and the resistance from A to earth $1800 + 5900 = 7700$



FIGS. 21 AND 22.



FIGS. 23 AND 24.

ohms. Hence total current entering line is $\frac{60}{7700} = .0078$ or 7.8 milliamperes. The drop along AB is $1800 \times .0078 = 14.04$ volts, the potential of B is $60 - 14.04 = 45.96$ volts, the leakage current at B is $\frac{45.96}{15000} = .00306$, and therefore the current in BC, $.0078 - .00306 = .00474$. This gives for the drop along BC the value $1800 \times .00474 = 8.53$ volts, so that the potential of C is $45.96 - 8.53 = 37.43$ volts. Hence the leakage current at C is $\frac{37.43}{15000} = .0025$, and the current along CD, $.00474 - .0025 = .00224$. This finally gives for the drop along CD $1800 \times .00224 = 4.03$ volts, and for the potential of D, $37.43 - 4.03 = 33.4$ volts.

The current and potential diagrams for this case are drawn in Fig. 24.

We have now fully explained the method of obtaining successive approximations, and we need only add that the degree of accuracy may be indefinitely increased by subdividing the line into more and more numerous sections, and distributing the leaks. The following tables give the values calculated for the case represented by Fig. 25, the line being divided into eight sections :

TABLE OF CURRENTS.

Section	AB	BC	CD	DE	EF	FG	GH	HK
Current in milliamperes	7.98	6.47	5.13	3.92	2.81	1.78	.79	0

TABLE OF POTENTIALS.

Point in line .	A	B	C	D	E	F	G	H	K
Potential .	60.0	52.8	47	42.4	38.8	36.3	34.7	33.9	33.9

These values are plotted in Fig. 26. Now we know that in the actual case the current does not decrease by sudden steps, but continuously. We further know that the current reaches a zero value not at the point H, but at the end of the line. The actual current curve will therefore be somewhat as shown by the chain-dotted curve of Fig. 26. The curve of potential distribution may be taken to be that passing through the various points plotted from the above table, and represented by the dotted line.

Taking the value of 7.98 milliamperes given by the last approximation as correct,* we see that the "measured insulation resistance" would in this case be $\frac{60 \times 10^3}{7.98} = 7518$ ohms, whereas the true insulation resistance is only 5,000. The necessity of applying a correction now becomes evident. If the conductor resistance of the line be known (which it generally would be, from the length, diameter, and material of the wire forming the line), then by *assuming* various values for the true insulation resistance, we could, by applying the method just explained, calculate the corresponding values of the measured insulation resistance. By plotting the former values against the latter, we should obtain a curve giving, at a glance, the true value of the insulation resistance corresponding to any "measured insulation resistance."

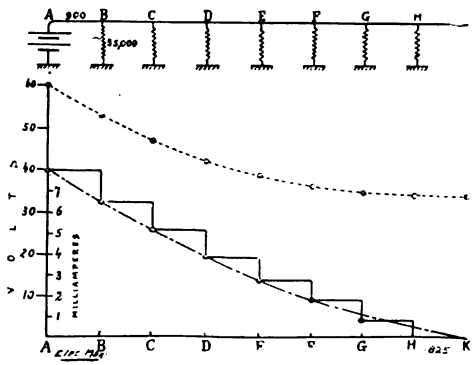
In the above investigation, the distant end of the line was supposed to be insulated. Let us now see what effect is produced by leakage when the far end of the line is earthed.

The principle involved in dealing with this case is precisely the same as that used in the former one. We assume that instead of a continuous leakage along the line there is a concentration of leaks at certain points. The greater the assumed number of points, the more closely will the arrangement correspond to the actual case, and the higher will be the degree of accuracy attained.

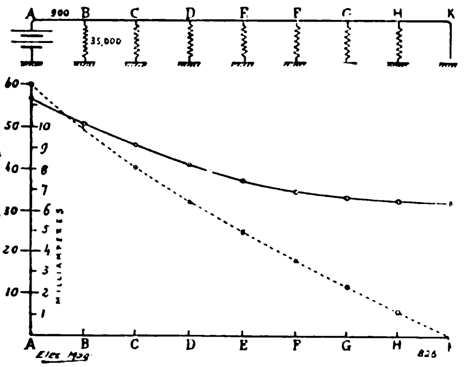
Let us assume that the line is divided into eight sections, and that leakage takes place at seven points, as shown in Fig. 27. This figure is identical with Fig. 25, except that the line is now earthed at its distant end.

The resistance between the point H

* The real value, calculated by a method involving the solution of a differential equation, is 8.34 milliamperes.



FIGS. 25 AND 26.



FIGS. 27 AND 28.

and earth is $\frac{900 \times 35000}{35900} = 877$ ohms. The resistance between G and earth is $\frac{1777 \times 35000}{36777} = 1690$ ohms. Proceeding in this manner, we obtain the following values:

Point in line	H	G	F	E	D	C	B	A
Resistance to earth	877	1,690	2,410	3,030	3,530	3,930	4,250	5,150

The current entering the line at A is thus $\frac{60}{5150} = .01165$. This current produces a drop in the first section AB of $900 \times .01165 = 10.48$ volts, so that the potential at B is 49.52 volts. The leakage current which leaves the line at B is therefore $\frac{49.52}{35000} = .00141$, and the current which passes on along BC is .01024. We thus obtain the following values:

TABLE OF CURRRENTS.

Section	AB	BC	CD	DE	EF	FG	GH	HK
Current, in milliamperes	11.65	10.24	9.09	8.17	7.46	6.95	6.61	6.44

TABLE OF POTENTIALS.

Point	A	B	C	D	E	F	G	H	K
Potential	60	49.5	40.3	32.1	24.75	18.05	11.75	5.8	0

These values are plotted in Fig. 28.

Of the total current of 11.65 milliamperes entering the line, only 6.44 milliamperes reach the far end, the remainder representing the leakage current. The total leakage current now amounts to 5.21 milliamperes as against the 7.98 obtained when the far end of the line was insulated.

It will be noticed that the "measured conductor resistance" amounts to $\frac{60}{.01165} = 5150$ ohms, whereas the true value is 7,200.

Various other problems may be solved by the aid of the same method. For example, it may be required to find to what potential the sending end of our leaky line must be raised in order to produce a given current through a relay of known resistance connected to the distant or receiving end of the line. Enough, however, has been said to enable the reader to deal with such problems.

ALTERNATING CURRENT WORKING.

(*Continued from page* 177.)

TRANSFORMERS.—The transformer consists of two electric circuits which are interlinked by a common magnetic circuit. The winding of the electric circuit which is supplied with electric energy is termed the *primary*, and the other one the *secondary*. The iron part of the transformer is built up of thin sheets of iron and forms the path of the magnetic circuit. When the electric circuits surround the core as in Fig. 1 (*I*), a *core-type* transformer is formed, whilst the arrangement shown in Fig. 1 (*II*) forms the *shell type*. The ratio of the number of turns in the secondary coil to the number of turns in the primary is called the *ratio of transformation*. A transformer having a ratio greater than unity is known as a *step-up* transformer, the current from the secondary being delivered at a higher voltage than the voltage at which it is received. When the ratio of transformation is less than unity the transformer is called a *step-down transformer*. Step-up transformers are employed chiefly for high tension transmission work when the generator pressure is limited. To get an insight into the elementary theory of the transformer we may consider the arrangement shown in Fig. 2 in which P and S are the primary and secondary coils and M is the iron core, and assume for the present that the secondary circuit is open. When current is supplied by the alternator A the primary coil acts merely as a choking coil, the impedance of which is very high so that it is almost entirely reactive, and on account of the

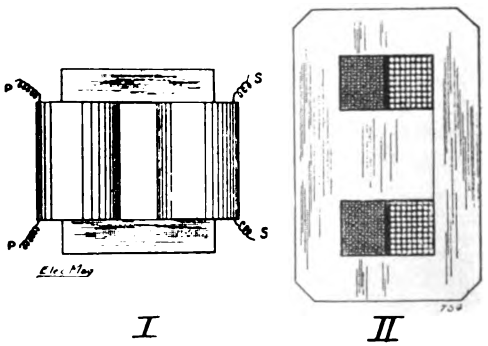


FIG. 1.

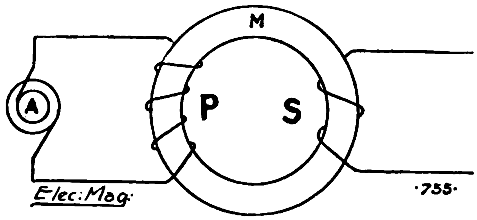


FIG. 2.

self-induction of the primary the current lags almost 90° behind the impressed E.M.F. The current in consequence is very small and only sufficient to magnetise the core and make up for the iron losses. The E.M.F. of self-induction of the primary lags 90° behind the magnetising or exciting current, and is, therefore, nearly 180° behind the impressed E.M.F. in phase (*i.e.*, is practically in opposition); the difference in magnitude between these E.M.F.s is small, being just sufficient to send the small magnetising current through the circuit. The vector diagram for an ideal transformer with the secondary circuit open is given in Fig. 3, in which OE denotes the primary impressed E.M.F.; OE[1] the primary E.M.F. of self-induction and OC is the exciting current producing the magnetic flux O*m*. Although no current is taken from the secondary circuit an E.M.F. is induced in the secondary winding by the alternating magnetic flux which traverses the secondary coil.

If the secondary circuit be now closed upon a non-inductive load such as a bank of glow-lamps a current is taken from the secondary circuit, and the actions taking place are as follows. The secondary ampere-turns will be directly opposed to

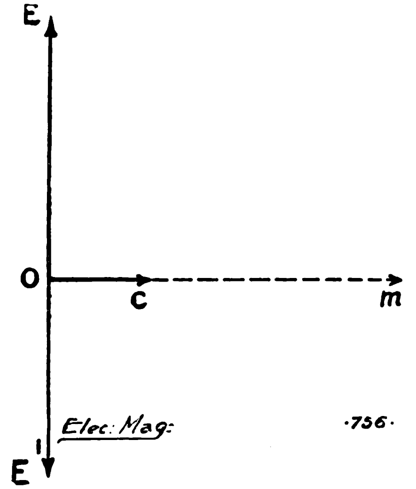


FIG. 3.

the ampere-turns of the primary, since the secondary E.M.F. is directly opposed to the primary impressed E.M.F., consequently a demagnetisation of the core results, which in turns reduces the E.M.F. of self-induction of the primary and the primary current is increased in a corresponding manner. In this way a readjustment follows the increase of the primary current and the magnetisation of the core is restored to the normal amount, and in fact is maintained practically constant, independent of the load on the secondary.

The vector diagram giving the pressure relations is shown in Fig. 4 (*I*), in which OC′ denotes the ampere-turns producing the magnetic flux. OC is the component of

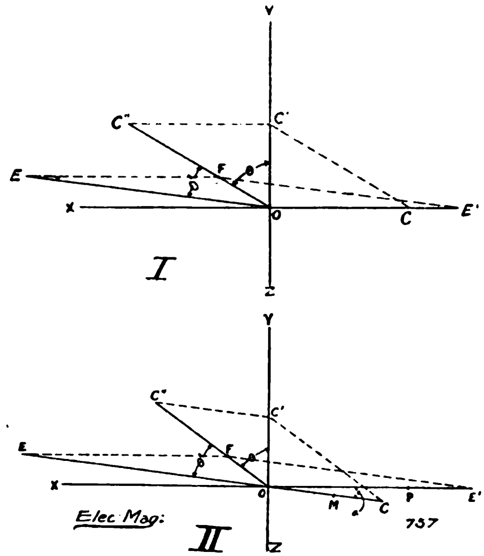


FIG. 4.

magnetism in the secondary whilst OC″ is the resultant or primary ampere-turns. A little consideration will show that the losses due to heating (C^2R losses), hysteresis and eddy currents are overcome by the pressure which is the resultant of the E.M.F. of self-induction of the primary (OE′) and the pressure (OF) in phase with (OC″). OE is therefore the primary impressed E.M.F. In order to show the phase relations of these pressures θ and θ^1 have been exaggerated in the figure.

The case in which the load on the secondary is inductive is shown in Fig. 4 (*II*), in which (OC) denotes the secondary ampere-turns, and the angle POC or α is the angle of lag which exists between the secondary pressure (OP) and (OC), the latter having the same phase relation as the current (OM) which coincides with (OC). As before (OC″) is the

resultant flux, and (OE) is the primary impressed E.M.F. As the load becomes more inductive the angle of lag θ^1 becomes greater, consequently Cos θ^1 decreases and the power factor of the circuit is lowered. A heavily loaded non-inductive secondary, on the other hand, will give a high power-factor. The relation between the E M.F., the flux N, the number of turns T forming a winding and f the frequency is given by the equation

$$E = 4.44 \, f \, NT \times 10^{-8} \text{ volts}$$

in which E will be the primary or secondary E.M.F. according as T is the number of primary or secondary turns. The factor 4.44 arises from the fact that the magnetic flux is created twice and is twice withdrawn during each cycle; thus the conductors are cut four times each cycle by the flux. The form factor for a sine wave is 1.11, hence the factor $4.44 = 4 \times 1.11$. N is the maximum value of the flux.

The losses which so far have been neglected, are

(1) Copper or C^2R losses

(2) Iron losses = (*a*) hysteresis losses + (*b*) Eddy current losses.

The heating or C^2R losses depend upon the load; when the secondary circuit is open the copper loss is $C_1^2R_1$ and is due to the exciting current only and is quite small. With a normal load the copper loss is given by

$$W_c = (C_1^2R_1 + C_2^2R_2) \text{ watts.}$$

The component of the iron losses due to hysteresis are given by

$$W_h = K_1 \, f \, V \, B^{1.6} \times 10^{-7} \text{ watts}$$

in which K_1 is a constant (0.002 to 0.003); f is the frequency; V the volume of the iron (in cubic centimetres) forming the core and B is the maximum value of the flux-density.

The other component, W_e, due to eddy currents are kept small by lamination of the core; they are given by

$$W_e = K_2 V f^2 B^2 t^2 \text{ watts}$$

in which K_2 is a constant ($1.6 \times 10^{-}$) and t is the thickness of the plates in centimetres.

The total core loss, $W_h + W_e$, is practically constant, although both wave-form and temperature influence the core less of a transformer. A rise of 40° C in the temperature will decrease the core loss between 5 and 10 per cent. A peaked wave form will give less core than a sine curve or a flat-topped curve, consequently when transformers which are operated from alternators giving a peaked E.M.F. wave are tested by a sinusoidal current the core loss is considerably higher.

The efficiency also depends upon the wave-form of the E.M.F. supplied, and the test for efficiency should be made with a non-inductive load, unless specific conditions make it otherwise. Since efficiency is the ratio of the output of power to the net input, the efficiency is given by

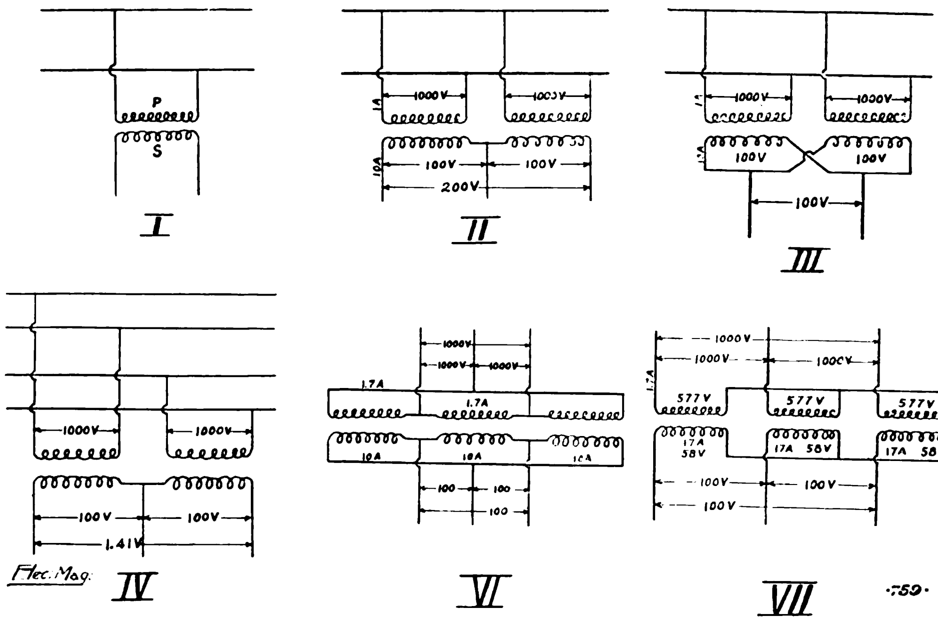


Fig. 5.

$$\eta = \frac{\text{output in watts}}{\text{output + losses}}$$
$$= \frac{E_2C_2}{E_2C_2 + W_c + W_h + W_e}$$

With transformers which are artificially cooled, as is the case with large transformers, the power expended in cooling must be included in the denominator. Since the losses are changed by temperature changes, the efficiency is also changed. consequently a definite temperature should be specified in connetion with efficiency tests.

The ratio of the energy output to the energy input during a run of twenty-four hours is termed the *all-day efficiency*. Under average conditions a transformer will be fully loaded for about five hours, and will have no load for nineteen hours out of the twenty-four. A transformer designed to be loaded but a short time should have a comparatively small amount of iron and a rather large amount of copper. This will reduce the iron loss during a twenty-four hours' run, and will increase the copper loss. The latter, however, only lasts during the short period in which the transformer has a full load.

Transformers may be connected together in various ways according to the condition under which they are to operate. The most important connections are shown in Fig 5. *I* shows a single transformer connected to a single-phase circuit, and it may be noted that a number of similar transformers may be paralleled on the line, and may have their secondaries independent or otherwise. *II* shows the secondaries of two transformers connected in series forming a three-wire system; the primaries are connected in parallel. In this case as well as in the others, the ratio of transformation is one to ten. By connecting the two secondaries in parallel, as in *III*, twice the current at the normal voltage may be supplied to a circuit. *IV* shows a two-phase system with the secondaries of two transformers connected in series; in this case the voltage between the outside wires is not twice the voltage on either leg, but is $\sqrt{2}E_2$ since the two pressures have a phase relationship of 90°. An interesting system devised by Mr. Scott for transforming a two-phase four-wire system to a three-phase system is shown in *V* (see opposite column). The pressure relations are shown in the figure on the right, and it will be noted that the secondary of transformer S is tapped at its centre by the wire W, and connected to one terminal of S[1]. If the number of secondary turns of S[1] is 86.7 per cent. of those of S, the pressure relations shown are realised, and the three vectors AB, BC, and CA indicate the three-phase pressures 120° apart.

VI shows three transformers connected

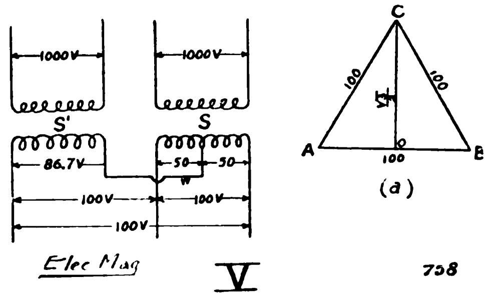


Fig. 5. Scott Two-phase-Three-phase Connections.

as a mesh combination on a three-phase system. This arrangement is most advantageous when continuous operation is demanded, for one of the transformers may break down, or be cut out, and the remaining two will carry the load. Under such circumstances they will each be over-loaded an amount equal to the difference between one-half and one-third full load, which is 16⅔ per cent. over-load. Three star connected transformers are shown in *VII*, and it is obvious that a breakdown of one transformer would result in disabling one line, and a lowering of the pressure between the other two, thus impairing the system.

Alternating Current Motors.—The great advantages of the alternating current for power transmission have naturally brought about the development of a motor which can be operated with alternating currents, and already the polyphase induction motor has reached a high state of perfection. The single-phase motor, pure and simple, possesses serious drawbacks and has not received much recognition in practice. Recently certain modifications have been introduced and the single-phase motor is now attracting considerable amount of attention. An alternating current motor which runs exactly in phase with the alternator supplying the current is said to be running in synchronism and is termed a *synchronous motor*. Any alternator, either single-phase or polyphase, may be connected with a source of alternating current and be operated as a synchronous motor if its speed is first brought up to a value corresponding to the frequency of the source. The speed necessary to attain synchronism will be the frequency divided by the number of pairs of poles or

$$\frac{n_s}{60} = \frac{f}{p}$$

where n_s = synchronous speed in revolutions per minute. In order to analyse the conditions of working of a synchronous motor it is usual to consider the combination of motor and generator.

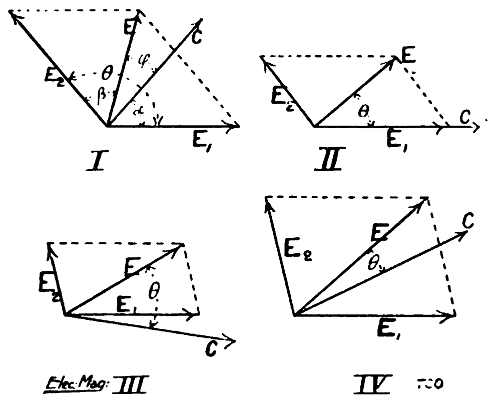


FIG. 6.

Thus, if E_1 = E.M.F. of generator
E_2 = E.M.F. of motor
θ = angle between E_1 and E_2
R = total resistance of circuit
X = reactance = $2\pi f L$

The E.M.F. which is effective in sending current through the motor is evidently the resultant of E_1 and E_2 whose phase difference is θ, as shown in Fig. 6 (*I*). The effective E.M.F. sending current through the circuit, and

$$E = E_1 \operatorname{Cos} \alpha + E_2 \operatorname{Cos} \beta \text{ (\textit{see} figure)}$$

therefore the current is

$$C = \frac{E}{\sqrt{R^2 + (2\pi f L)^2}}$$

also

$$\tan \psi = \frac{\text{reactance}}{\text{resistance}}$$
$$= \frac{2\pi f L}{R}$$

an expression which determines the angle of lag between the impressed voltage E and the current C. The vector diagram indicates that when the value of the power factor is at any value but unity pulsations will be given to and received from the generator. If P_1 = power given by the generator and P_2 = power given by the motor, then

$$P_1 = E_1 \operatorname{Cos} (\alpha - \psi)$$
$$P_2 = E_2 \operatorname{Cos} (\beta + \psi)$$

It should be noted that during each cycle there will be four power pulsations. This fact will at once become evident if sine waves are plotted having the same phase relations as those of Fig. 6 (*I*). If an alternation in phase between the motor and generator results in the motor receiving increased power the motor is *stable*, but if a change in phase has the opposite effect it is *unstable*. There are certain limits of the phase angle θ beyond which if a load be increased the motor will fall out of synchronism and finally stop. There are several causes for this. Among them are variations in the frequency of the generator, and suddenly applied loads on the motor. Variations in the speed of the alternator are productive of an oscillatory movement known as *hunting*. It is often caused by the failure of the engine governor to respond promptly to changes of load. If a means is not used to overcome hunting, it may become quite serious, especially when generators are operated in parallel. It is obvious that the inherent causes of hunting is due to the inertia of the armature, consequently it may occur in a synchronous motor as well as an alternator.

Since the current lags behind E by an angle ψ, it follows that if E_2 be altered, a change in the value of ψ will result, and it may be either lagging or leading. The variation in E_2 is made by varying the field excitation of the motor; several effects are shown in Fig. 6 (*II*) (*III*) and (*IV*), and it will be observed that if the motor field be over excited it will cause a leading current which produces the same effect as a condenser in the circuit. In this way the synchronous motor may be used to neutralise inductance and thus keep up the power factor. Synchronous motors are often employed in this way on transmission systems since inductive disturbances may be overcome and good regulation thereby maintained. When synchronous motors are used for this purpose they are generally run without any load, or with but a light load, and their fields are excited to meet the particular conditions under which they operate.

Synchronous motors are generally started by some outside source of power. On polyphase systems an induction motor is generally employed. The capacity of such a motor need be but one-tenth the size of the synchronous motor. In the case of polyphase machines it is possible to start synchronous motors without any outside source by opening the field circuit and supplying polyphase current directly to the armature, and as the result eddy currents are induced in the field poles to the extent of producing a starting torque and the armature is set in motion and very quickly approaches synchronism. When synchronism is attained the field is excited and the motor continues to run, after which the load may be applied by means of a friction clutch or similar device.

When starting a synchronous motor by the method first described, great care is necessary because of danger of rupturing the insulation of the field coils. The cause of this danger is due to the high voltage brought about by the rapidly varying flux in the pole pieces. The danger may be lessened by separating all the field spool connections, confining the difference of potential to that of one spool instead of several.

It is well known that a series direct-current motor may be operated by an alternating current, the nature of the motor being such that the direction of rotation is fixed, regardless of the alternating flux, since both the field current and armature current change simultaneously. Suppose, that instead of passing the current directly through the armature, we short circuit its coils, and excite the field with an alternating current. An E.M.F. will then be induced in the armature coils, which may be compared with the secondary of a transformer. The self-induction of the armature (secondary circuit) will, on account of the iron core, be highly inductive, and consequently the current will lag behind the impressed E.M.F. of the armature by a phase difference of more than 90°. Now, if a curve be plotted by taking the product of the current and magnetism in the armature, it will represent the torque, and it will be seen that the positive lobe of the curve will be less than the negative throughout each cycle, a repulsion being set up between the field and the armature, greater than the attractive force. This arrangement constitutes a *repulsion motor.*

A repulsion motor is not self-starting unless an arrangement is made whereby the flux induced in the armature (or part of it) has a fixed relative position which will produce a starting torque. Normally the repulsions of the armature coils are all balanced against that of the field. If, however, the armature is once started, a differential effect occurs which changes the relation between the field and armature, maintaining a continuous torque.

Single-phase motors are not highly efficient, and are large for their output. They are much cheaper, however, than polyphase motors, and are quite satisfactory in small sizes; hence they have an important place in small installations.

COMPARISON OF THE ELECTROMOTIVE FORCE OF BATTERIES. (II.)

THE arrangement for the apparatus for comparing the E.M.F.s of two batteries, as devised by M. D. Negreau, is shown in Fig. 1. Let E and E_1 denote the E.M.F.s of the two cells or batteries, B and B_1 their internal resistances, and G the resistance of the galvanometer. The test consists in adjusting the resistances R and R_1 by means of two resistance boxes, until the galvanometer deflection remains unaltered, when the two points *a* and *b* are either connected or disconnected, *i.e.*, when the two points *a* and *b* are at the same potential. The currents are denoted by C, C_1 and C_2, and the resistance of the branch *ab* by R_2.

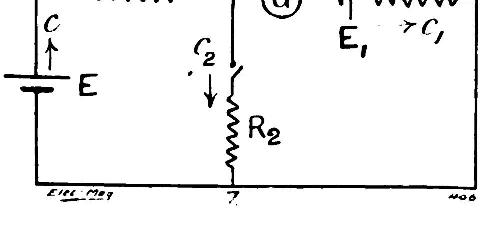


FIG. 1.

By Kirchhoff's laws,

$$C = C_1 + C_2$$
$$E = C(B + R) + C_2R_2$$
$$E_1 = C_1(G + B_1 + R_1) - C_2R_2$$

When R and R_1 have been adjusted until the galvanometer deflection is unaltered by removing the branch *ab*, C_2 is zero, so that

$$C = C_1$$
$$E = C(B + R)$$
$$E_1 = C(G + B_1 + R_1)$$

from which

$$\frac{E_1}{E} = \frac{G + B_1 + R_1}{B + R} = K \ldots (1)$$

A second test is then made in which the resistances R and R_1 are augmented by amount r and r_1, and so adjusted that the galvanometer deflection is unaffected by the insertion and removal of the branch *ab*, in which case

$$\frac{E_1}{E} = \frac{G + B_1 + R_1 + r_1}{B + R + r} = K \ldots (2)$$

From equations (1) and (2) we have

$$G + B_1 + R_1 + r_1 = K(B + R + r)$$
$$G + B_1 + R_1 = K(B + R)$$
$$\therefore (G + B_1 + R_1 + r_1) - (G + B_1 + R_1) = K(B + R + r) - K(B + R)$$
$$\text{and } r_1 = Kr$$
$$\therefore \frac{r_1}{r} = K = \frac{E_1}{E}$$

From Professor to Student.

I SHOULD be glad to know what scholarships are open to a lad of sixteen who is just leaving school, and desires to enter the profession of electrical engineering.

We should advise our correspondent to obtain the prospectuses of the Central Technical College, Exhibition Road, S.W.; the Finsbury Technical College, Leonard Street, Finsbury, E.C.; and the Electrical Standardising, Testing, and Training Institution, Faraday House, 8 and 10 Charing Cross Road, W.C. In these, he will find full particulars regarding scholarships, as well as details regarding the courses of instruction.

I AM at an engineering school in one of the polytechnics, and hope to finish my course there by September. Would you advise me then to go to one of the higher-class engineering schools, and, if so, could you name a few? Then, as to practical training, how long should I spend in the shops? I should also like to know what advantage there is in passing the London Univ. Exam. in Engineering.

The best course of action for our correspondent depends partly on his age, partly on the standard of instruction in the Polytechnic which he is attending. If this standard is not as high as in a University College, and if our correspondent is still very young, we should strongly advise him to spend at least one session at the Central

Technical College (Exhibition Road, S.W.), taking the third year's course. This should be supplemented by at least two years' work in the shops, where arrangements should be made, for as large a variety of work as possible (it is not necessary that the first year of workshop practice be spent in an electrical engineering shop; any good general engineering workshop will do just as well; the second year, however, had better be devoted to electrical work exclusively). If, however, our correspondent's age exceeds nineteen, we should advise him to go into the shops immediately on leaving the Polytechnic, and to complete his theoretical training, if necessary, afterwards. During his period of workshop training he should attend advanced evening classes. As regards the advantage of possessing a University degree, this is undoubted and fairly obvious: it stamps a man with a universally recognised hall-mark of a certain standard of intellectual attainment.

WOULD you advise an apprentice electrician, sixteen years of age, who has spare evenings, to tackle the London Matriculation Exam.? If so, what subjects would you advise? Also, could you let me know through your magazine particulars concerning the admission to the Students' Section of the Institution of Electrical Engineers?

We should certainly very strongly advise our correspondent to try the matriculation examination, and, as regards subjects, we should consider the following very suitable: (1) English; (2) elementary mathematics; (3) elementary mechanics; (4) elementary chemistry; (5) elementary electricity and magnetism.

By writing to the Secretary of the Institution of Electrical Engineers, 92 Victoria Street, London, S.W., our correspondent can obtain a form of application for studentship. This form will have to be signed by a Member or Associate of the Institution (a single signature is sufficient), and then forwarded to the Secretary.

A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section at end of Magazine.

Manufacturers and the Electrical Congress.

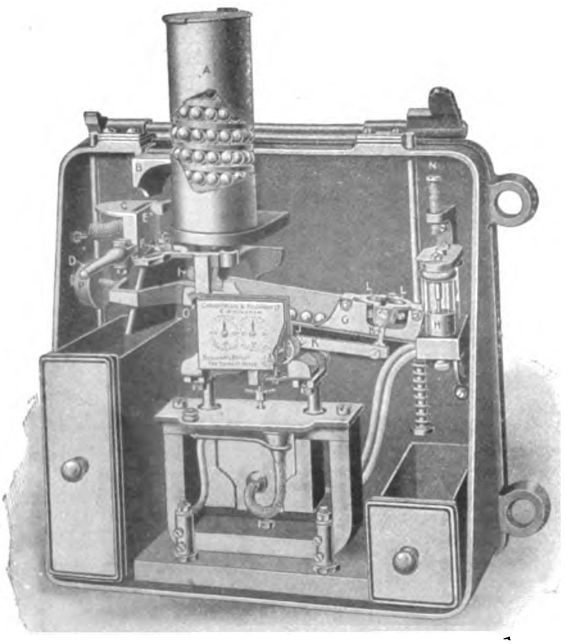
The International Electrical Congress just closed cannot but be of intense interest to all manufacturers of electrical apparatus. Apart from the assembly of so many electrical men of repute at an exhibition in which electrical manufactures of every quality and kind are open for inspection, the discussion by these representative heads of the industry of matters of vital concern to it and all associated with it must be a matter of great purport to those whose special duty it is to furnish the market with modern electrical machinery. We make announcements throughout this issue of our intention to treat exhaustively of the Congress, Exhibition, and Tour of electrical engineers in a special manner, and to the issue containing this we must refer our readers on its publication. We think it timely, however, to preface the Manufacturers' Section this month with a few remarks on those papers read which directly concern the producer and are likely to influence his designs or assist him in some way in the manufacture of his goods.

Any modern work of even moderate pretensions to size should possess a testing laboratory, and the remarks of Dr. C. H. Sharp on the equipment of so important a works adjunct contain useful matter for the guidance of those contemplating such a department. Mr. B. A. Behrend supplies valuable data for testing alternators under full load conditions without the application of full load. His method is to split the field into two sections, so that the E.M.F.s induced in the armature are in opposition. Incidentally we may refer here to an article by Mr. Behrend recently published in the *Electrical Review*, New York, on the design of turbo-alternators. The information contained therein should be in the hands of every maker of turbo-generators, and we commend it to manufacturers' notice. Prof. C. P. Steinmetz, the American authority on alternate-current motors, gives a paper discussing mathematically all standard types of alternate-current motors, synchronous, induction, and commutator, and Mr. O. S. Bragstead treats of the theory and operation of the repulsion motor. Max Deri deals with single-phase motors, describing his own special arrangement (*see* Special Articles this month), and the theory of the compensated repulsion motor is also fully dealt with by Mr. E. Danielson. These motor papers were fully discussed. Colonel R. E. Crompton laid before the Congress particulars of the work of the Engineering Standards Committee in this country. The nature of insulating materials for high pressures is always a matter of importance, so that the remarks of Professor H. J. Ryan on the design of high-pressure insulation are pregnant with interest. We have constantly urged in these columns the necessity for motor-driving in workshops, consequently we heartily endorse Mr. C. Day's remarks on electric motors in machine-shop service, in the course of which he emphasised the need for regarding the motor-driven tool not as a combination but a unit suited for certain specific ends. Mr. A. Heyland has long associated himself with the design of compound alternators, and in view of the importance of such a machine his reference to the system bearing his name appears opportunely among the papers read before the Congress. When fuller details of the papers are to hand we shall present more comprehensive abstracts of them for our readers' reference.

A NEW PREPAYMENT METER.

CENTRAL station engineers realised long ago that there was a field and a remunerative one from prepayment consumers. Coin-freed electrical devices without number have been patented, but few have survived the test of commercial application, and to-day practicable prepayment electricity meters could be counted probably on the fingers of one hand. Messrs. Chamberlain and Hookham whose name has been inseparably associated with electricity meters for many years past, have recently introduced a prepayment meter (Hookham's patent), which has many novel features. What many meters accomplished by a mass of clockwork this type performs by the subsidiary assistance afforded by a series of "checks" which are freed by the coin and do all the necessary switching. The interior of the meter is exposed in the adjoining figure and the following describes the method of its operation.

A is the check reservoir, drawn to exhibit the checks consisting of a number of small steel spheres contained in a spiral groove. The checks are inserted at the top and escape one at a time at the bottom. B is the slit into which coins are inserted so as to fall into the receptacle C. D is a lever projecting through the front of the case. After a coin has been inserted and fallen into C, the lever D is moved to the left; the coin standing edgewise in C first encounters and lifts the catch E, thus allowing of D being moved still further; it then falls over the edge of an inclined plane F, which prevents D returning until the coin has been discharged into the drawer on the left. The forward movement of D works a small pusher under the check reservoir which carries out a check and drops it into the pivoted beam G. One check is sufficient to depress the beam, thus making contact by means of the mercury cups H, and permitting a supply of current to pass to the lamps. Six or eight checks may however remain in the beam, allowing the customer to put in eight coins at a time. Each check as it falls into the beam passes over and tilts a small weighed lever at I, which is so arranged that if the beam becomes full of checks more cannot issue from the reservoir. This in turn prevents any more coins being inserted until, under the action of the meter, a check has passed from the beam. The release of the checks from the beam is effected through the medium of the counting train of the meter. One of the wheels carries the crank-pin J, which, in rotating, rocks the connecting rod and lever KK backwards and forwards. To the lever K is attached a horizontal bar carrying two small vertical screws LL; the whole arrangement forms a kind of escapement, the slow to and fro movement of which releases the checks one at a time. The speed of the meter and the wheel train of the counter are so adjusted that the desired value in current releases one check from the beam. After escaping from the beam each check falls into the check drawer on the right-hand side of the meter. The coin and check drawers are secured by vertical spring bolts at the back of the meter, which are depressed by the movement of a horizontal bar along the top of the case. The movement of this bar also actuates a cover for the check reservoir, and it carries a lid which seals a small hole in the case. This hole is provided so that a screw-driver can be inserted for the purpose of raising the screw N. This screw when down presses the end of the beam firmly down upon the mercury cups, effectually sealing them up and preventing loss of mercury in transit.



CHAMBERLAIN AND HOOKHAM'S PREPAYMENT METER, OPEN

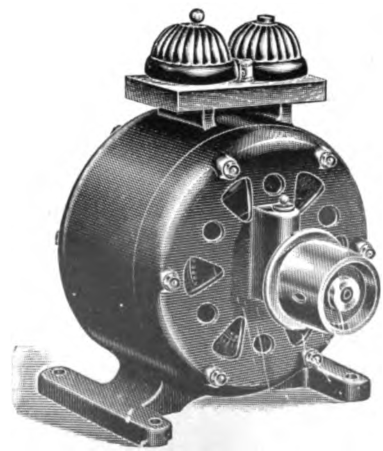
Different counting trains are fitted according to the price per unit charged, and the meter will take either pennies or shillings. From the foregoing description it will be seen that the arrangement is extremely simple and

PREPAYMENT METER, CLOSED.

with the exception of the mercury cups there is little to get out of order. The latter are, however, specially arranged for shipment and special precautions are taken to ensure efficient contact at the mercury while a layer of oil about ¼ inch deep floats on the surface to prevent sparking, and keeps the mercury clean. We should anticipate a wide sale for this device, seeing that it is so extremely simple, and is free from complicated clockwork. We understand that it is already on circuit in a number of small towns and in districts where the prepayment consumer is chiefly located. It is made for both continuous and alternate current service

ALTERNATE CURRENT MOTORS FOR SMALL POWERS.

CONSIDERING the number of people who require motors, of from 3 b.h.p. downwards, it is extraordinary that in England the matter of their exploitation should have received so little attention. This is particularly the case with regard to alternating current. Many hundreds of alternate current motors are running in this country, yet only a few firms manufacture specially for the purpose. Among such firms the Crypto Electrical Company of 3 Tyers Gateway, Bermondsey, has recently devoted considerable time and capital to the development of two forms of alternate current motor, one of which is shown in the accompanying illustration. It is well known of course, that alternate current motors, unless of the commutator type, must have some special device for starting them up. In small motors of the induction type this device usually takes the shape of an apparatus "for splitting the phase," sometimes embodied in the motor itself, sometimes placed in a separate starting switch. Of motors of the former variety there are two distinct types, namely, those with starting coils of low resistance and high self-induction, such as the Heyland, and those with starting coils of relatively high resistance, and small self-induction, of which the Crypto is an example. In this motor the starting coils are of wire of a gauge finer than that employed in the running coils, and are placed farthest from the roots of the stator teeth, which are formed so as to leave slots of the half open type. From the illustration below it will be seen that on the top of the motor there are two switches, one of which is a spring push. To start the motor, the alternate current mains are connected to the terminals found on the top, both switches on the top are closed, the push switch being held down till the motor attains about two-thirds of synchronous speed, when it is released and the motor immediately seems up to full speed and carries its load as an ordinary single phaser. The second type of motor made by the Crypto Electrical Company is a special form of repulsion motor, which after much experiment has been developed from that described by Mr. W. Cramp, in his paper before the British Association in 1903. The main defect of repulsion motors is the fact that from two-thirds synchronism up to one and a half

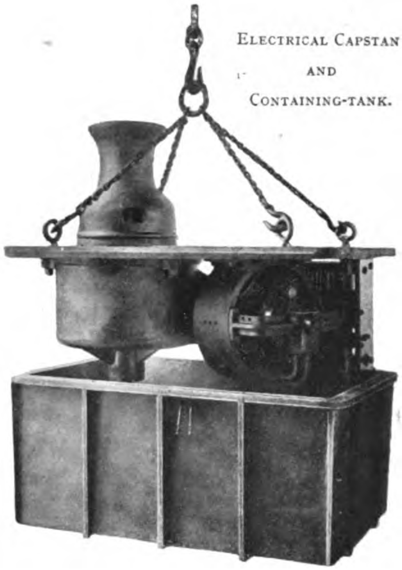


SMALL A.C. CRYPTO MOTOR.

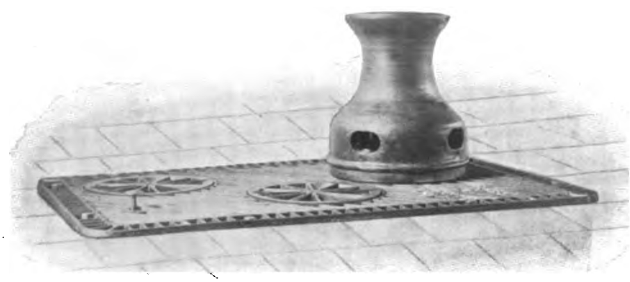
times synchronism, the torque is small and falls off very slowly, so that though the motor running light may attain to a very high speed, the least load brings down the speed, perhaps, 40 per cent. In the Crypto Electrical Company's motor this deficiency has been overcome by the addition of a second short-circuited winding over the ordinary repulsion armature coils. The effect of this winding is three-fold, and its number of turns, &c., have been the cause of much calculation and experiment before it arrived at its present condition: firstly, for a given current the starting torque of the motor is somewhat decreased, but inasmuch as in well made repulsion motors this is very large, a slight reduction constitutes no serious disadvantage. Secondly, the special winding prevents the rotor attaining such a very high velocity if left running light, which is an obvious advantage, and thirdly, it infuses into the motor characteristic some of those good points of the induction motor, resulting in an increased torque near synchronous speed with much more rapid alteration of torque for a small change of speed than is ever obtained with pure repulsion motors. We might also mention that the presence of this second winding ensures perfect commutation, so that upon all motors which the Crypto Electrical Company have at present turned out of this type copper gauze brushes have been used. There is without doubt a great future for motors of this type when once the prejudice which at present exists against commutators in alternating electrical machinery has been lived down, as it must be within the next few years.

A NEW LINE OF ELECTRICAL CAPSTANS.

The employment of electric power in docks and harbours is causing the electro-motor to do the work once specially allocated to steam, and as a consequence it is not surprising to see among other apparatus to be electrically driven, that time-honoured adjunct of the quay side, the capstan. The days of a merry crowd of sailors whirling the capstan to the tune of the flute have long since passed, and one man now does the work of many. Messrs. Walker and Hodgetts, Ltd., Salford, are manufacturing a compact and accessible form of motor-driven capstan which we illustrate herewith. The motor, together with speed reduction gear and also the starting switch and connections are mechanically fixed to a strong ribbed foundation plate, and the whole of the parts can thus be raised from or lowered into the watertight tank. This tank is provided with a machined flange to make a weather-proof joint between tank and plate. The motor is series wound and the capstan is operated by pressing and releasing the foot pedal to start and stop respectively, the switching gear being in all other respects automatic. Two circular inspection covers are provided in the top plate, these being placed in positions which enable the attendant readily to inspect the bearings and the commutator. The speed-reduction gear consists of machine-cut worm and worm wheel which both run entirely immersed in an oil-bath. The lubrication of the shaft bearings is also automatic. The entire apparatus is made to withstand rough usage and exposure to the weather in order to meet the



Electrical Capstan and Containing-tank.

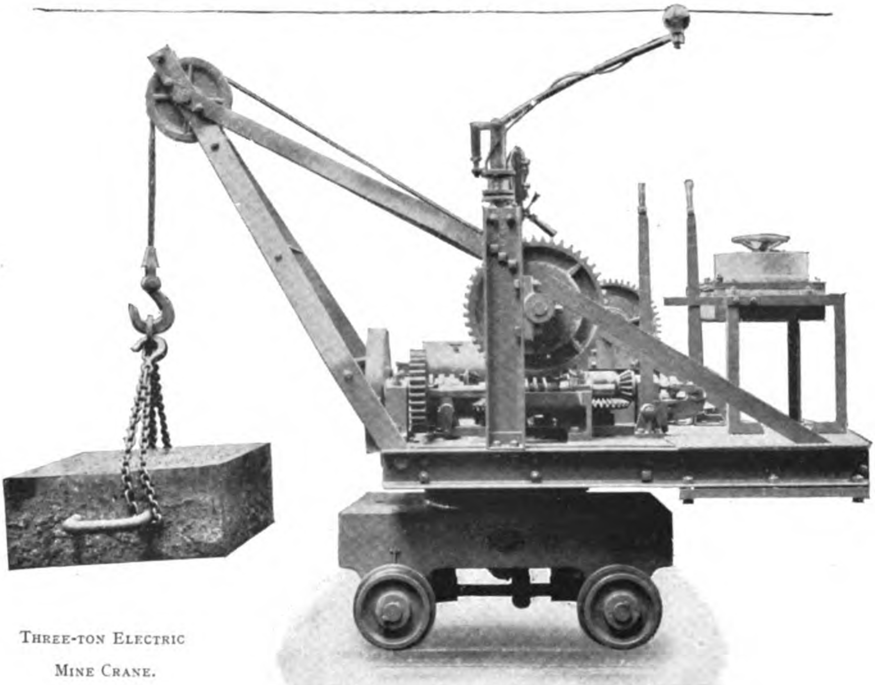


Capstan in Position, showing Inspection Doors.

requirements of railway and other goods yards, where a simple form of haulage is essential.

ELECTRIC CRANES FOR MINES.

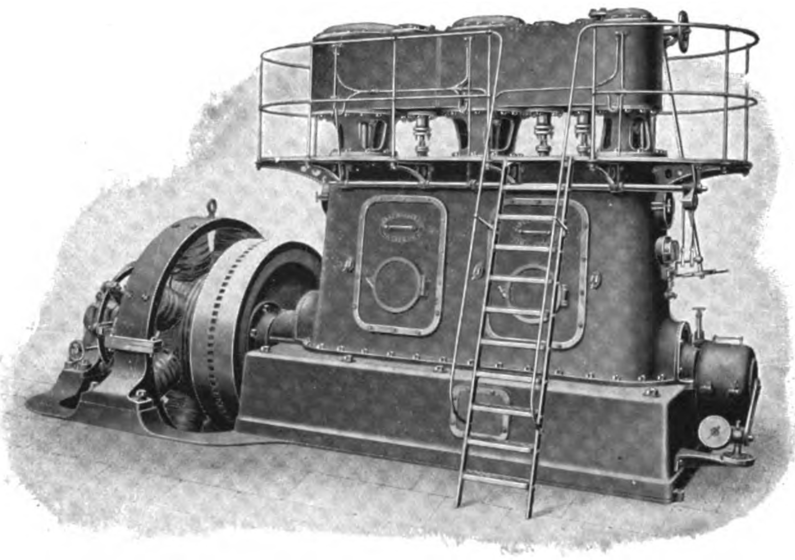
THE advantages of a crane in certain mine workings are undoubted, and where electric power is available they become even more pronounced. Seeing that power can be supplied through overhead trolley or by flexible cable, the apparent difficulties of making the crane a travelling one are at once obviated Our illustration depicts a type of electric crane for below ground service, which is being introduced by Jessop and Appleby Bros., Leicester. Its capacity is three tons and slewing radius 5 ft., while a clear lift of the load of 5 ft. 6 ins. above rail level is obtained. A massive under carriage on which is mounted the revolving superstructure, is fitted with four chilled iron flanged wheels for travelling on a 2 ft. 6 in. track. The superstructure revolves on anti-friction rollers, bearing on a turned roller path on the under carriage, this path being removable. The motor, which is enclosed, and all other gear are mounted on the superstructure and revolve with it. Current is collected from an overhead wire by a trolley of the usual type though, of course, much shorter. The controller is fixed at the rear of the platform from which the main levers are readily accessible.



THREE-TON ELECTRIC MINE CRANE.

HIGH SPEED ENCLOSED ENGINES.

IN spite of the activity of steam turbine makers, there is still a field for the reciprocating engine for comparatively small powers. The double-acting high-speed vertical engine for direct connection to dynamos has done much to advance the commercial progress of electric lighting, consequently every credit is due to makers of these engines for their part in the work. Messrs. James Howden and Co., Scotland Street, Glasgow, have recently sent us particulars of their high-speed engines, and we illustrate a typical engine made by them for electric lighting and power purposes. It represents the arrangement of their larger engines, but smaller-sized compound sets are also built. The two-crank compounds are built for loads up to 200 b.h.p., and the three-cylinder compound and triple expansion sets from 375 to 1500 b.h.p. The engines are all substantially built, and a large number of them are in active service coupled to dynamos in various parts of the kingdom. The working parts are enclosed in a strong vertical



650 H.P. ENCLOSED ENGINE AND DYNAMO.
(*J. Howden and Co.*).

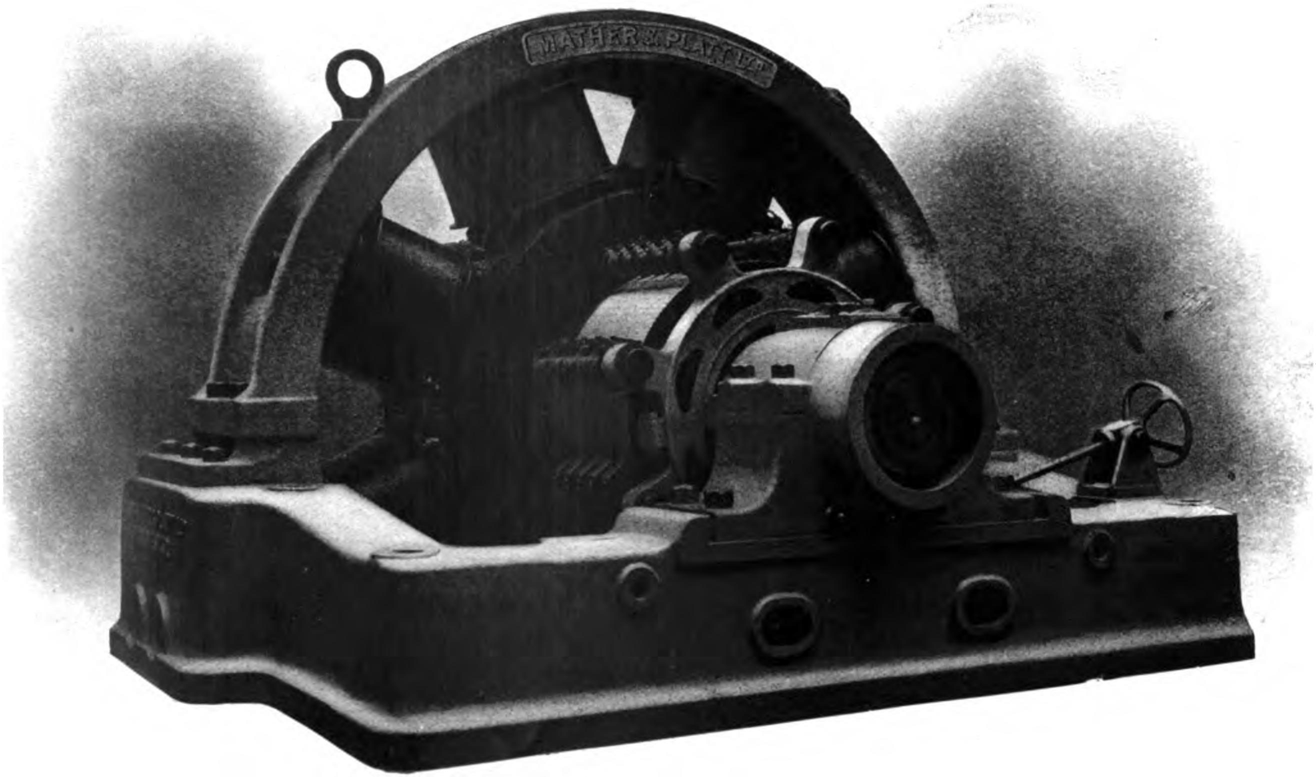
casing, accurately machined top and bottom, and securely bolted to the base. Large doors secured by nuts are provided at both sides, giving unrestricted access, and small hinged-doors opening with one handle, are provided for ready access to facilitate examination. Distance pieces carrying the cylinders are secured to the top of the casing. Sufficient height is provided to ensure that the oil is not drawn up from the crank case to L.P. cylinder when working condensing. The cylinders are of the best hard close-grained cast-iron, in one piece, with valve casing between them, fitted to a patent double-ported piston valve distributing steam to both cylinders. The cylinders are covered with blue planished sheet steel, and polished cast-iron covers are fitted over cylinder covers and valve chest covers, the space underneath being filled with asbestos fibre. The pistons are in one piece, the L.P. being of cast-steel. Two cast-iron packing rings, accurately machined, are fitted to each piston, the arrangement being specially suitable for high pressures and high temperatures. The piston rods and valve rods are provided with metallic packings. The piston rods are of high carbon steel, accurately finished, guide blocks and rod being finished together, ensuring exact alignment. Connecting rods are seven times the length of cranks, thereby reducing pressure on guides and conducing to exceptionally smooth running and absence of vibration. The crank shaft is of Siemens Martin steel, with throws cut out of the solid. There are four bearings in the crank case, giving exceptionally large bearing surfaces, all being lined with Richards anti-friction metal. The cranks are placed opposite to each other, and are balanced. The governor is carried directly on the crank shaft, and actuates a double-beat throttle valve, and the speed-regulating gear admits of 10 per cent. variation while the engine is running. Messrs. Howden have also acquired rights to manufacture steam-turbines in Parson's patents and have already secured, among others, an order from the New South Wales Government for machines of 1,500 to 2,000 k.w. for Sydney.

Settlement of the Dispute at Graham, Morton, and Co.'s Works, Leeds.

IT is not often that a dispute involving some hundreds of skilled workmen and their employers is settled with such promptness, and so thoroughly as that which recently induced the boiler-makers, employed by the above-mentioned firm to leave their work in a body. In this particular instance the spirit of firmness on the part of the employers, in maintaining absolute freedom to employ in their works non-unionists equally with unionists, leavened with a spirit of conciliation, by which Mr. Maurice Graham was induced to accord an interview to the representatives of the executive council of the Boiler Makers' and Shipbuilders' Society, are, in a large measure responsible for the happy results.

Multipolar Generator.
Mather and Platt, Ltd.,
Salford Iron Works,
Manchester.

8 pole dynamo. Output 380 k.w. 120 volts. Speed, 320 revs. per min. Suitable for direct coupling to high-speed engine.



Standard Types of Electrical Apparatus. IV.

The World's Electrical Literature Section at end of Magazine contains a classified list of all articles of interest to Central Station men. Consult it and save yourself much valuable time.

"Faults" on Underground Mains: A Remedy—IV.

By JAMES CLEARY.

(Continued from page 301.)

MAINS engineers generally have their own method of locating "faults," and for various reasons this must continue to be so, but the difficulty has been to determine its position when the "fault" was located to a length of cable. There are some tests which give good results when the conditions are favourable to their application, but a reliable test under all conditions will be welcomed by all engineers who know the need of it. The need of such a test was clearly demonstrated in a recent correspondence—more amusing than instructive—in a contemporary. One method advocated requires the house service leads on defective main to be short-circuited on consumers' premises—there were two claimants to this method, and they are certainly welcome to it for what practical use it is. Another writer had a "fault" on an *important* main "up his sleeve," and kept it there until Bank Holiday, when, instead of taking holiday, he tried the short-circuiting method without success. It might be inconvenient —even metaphorically speaking—to have a "fault" up one's sleeve, if another of opposite polarity came on at the same time. Setting criticism aside, the author would like to point out that the tests here advocated can be applied *without access* to consumers' premises — a necessity on any important net-work, where the tests have frequently to be made after midnight.

The following test is a drop of potential method devised by F. C. N. Bergh, and has been used with success on all classes of cable varying in size from 1 sq. in. feeders to single arc lamp cables. It is independent of the resistance of "fault," and though lead connection *is not* necessary it can be applied to a two or three-wire net-work, and is equally efficient on a "dead earth," or a "short circuit" with high insulation to earth. Neither galvanometer nor battery is required, the testing current being taken from the mains. The test can be applied easily inside ten minutes, and the "fault" often removed in less time than it takes to prepare for some of the more elaborate tests. The only occasion that this test has been known to fail was in the case of two "faults" being on a cable at the same time, certainly an all-sufficient reason!

The testing-set Fig. 1—made by Elliott Bros. — consists of a Weston ammeter

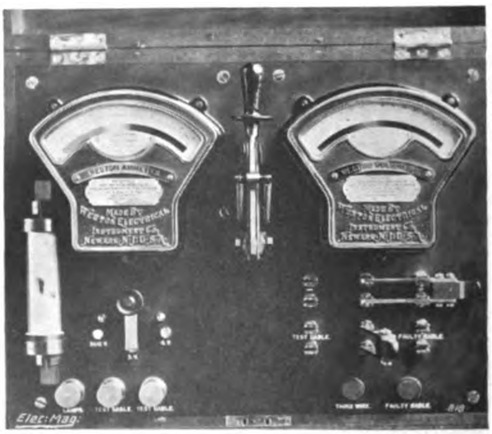


FIG. 1. TESTING-SET.

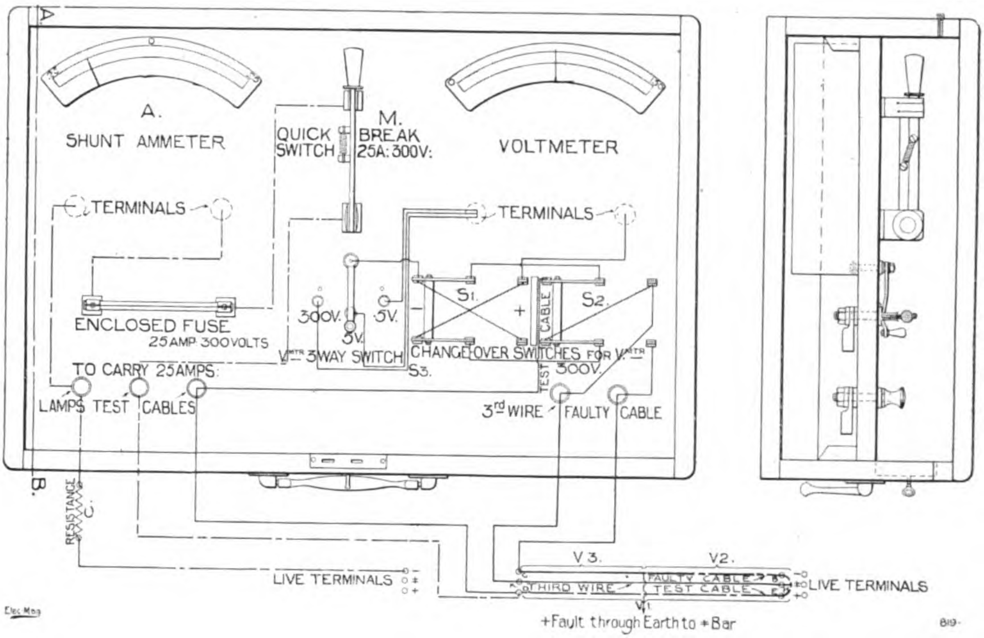


FIG. 2. DIAGRAM OF TESTING CONNECTIONS.

polarised and reading from 0 to 25, a Weston voltmeter with three ranges, 0 to .5 volts, 0 to 5 volts, and 0 to 300 volts—resistance of smallest coil should not be less than 25 ohms; main switch to control current, and two change-over switches for taking drop on good and faulty cable without altering connections; a three-way voltmeter switch for changing from one coil to another, and a resistance, preferably a bank of twelve 50-c.p. lamps wired in a suitable box. Fig 2 shows arrangement of connections on testing set, also faulty section of three-wire main connected up ready for test. All three "dead" cables are cross-connected at "EHB," bank of lamps "C" is connected to "live" outer, the other end being coupled through ammeter "A" and main switch "M" to the good "dead" outer "DE." from "DE" the current passes through loop "EB" to faulty cable "BG," passing along "BG" to fault "F," and then through earth to neutral bus-bar which is earthed at works, the third wire "HK" being simply used as a voltmeter lead.

First obtain V_1 by connecting voltmeter across "DK" (good cable) at the same time noting current A_1, this is done by closing main switch "M," and switch S_1 is put over to + or − side, according to polarity from which supply is taken, switch S_2 is then put over to side marked "test cable," readings A_1 and V_1 taken simultaneously.

Secondly, obtain V_2 by connecting voltmeter across "KG" (faulty cable) by changing over switch S_2 to side marked "faulty cable," at same time noting current A_2.

Thirdly, obtain V_3 by removing lead from faulty cable, and connecting both leads marked "test cables" to faulty main at "G," then reverse S_2 to side marked "test cables" at same time noting current A_3.

These results give two determinations, the length and cross-section of cables being known. In No. 2 test if the difference between the cross-section of good cable and cross-connection be great allowance must be made.

Test No. 1.—Comparison of the two portions of "faulty" cable.

Let D be the length of main.

Let A_1 be the cross-section of good cable "ED."

Let A_2 be the cross-section of faulty cable "BG."

Distance of "fault" from testing-end =

$$\frac{V_3A_2D}{V_2A_3 + V_3A_2}.$$

Test No. 2.—Comparison of one portion

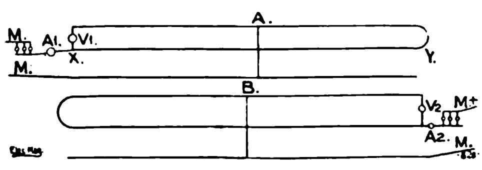


FIG. 3.

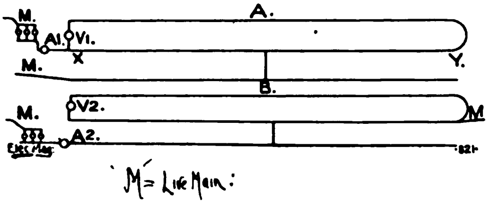


Fig. 4.

of "faulty" cable "FG" with the good cable as a check test.

Distance from testing-end = $\frac{A_1V_3A_2D}{A_3V_1A_1}$

Fig. 3 A and B show connections for test on "short circuit" on three poles without earth. "B" is a repetition of "A" at other end.

Distance from X = $\frac{V_1A_2D}{V_1A_2 + V_2A_1}$.

Fig. 4 A and B show connections for test on "short circuit" between two poles, and no earth. Practically all the testing is done from one end.

Distance from X = $\frac{V_1A_2D}{V_1A_2 + V_2A_1}$.

The analyses of six consecutive tests are here given—the number could be multiplied by ten if space permitted. Each "fault" was found by opening one hole, which is a great consideration where the roads are wood, asphalte, or other costly paving. They are of recent date, and only cover a period of eight days, some of them being nearly a mile distant from works, and the average time of clearing each "fault" after test was taken was less than two and a half hours.

Another test worthy of note was on a mile of 1 sq. in. single cable, laid on the solid system, with lead broken at each straight joint. The test gave 275 yards, which proved correct. The author recommends this test as being reliable, and has proved its efficiency when other methods have failed. The testing-set here described is made up in a compact form enclosed in portable case, and is admirably adapted for its work. A set of leads of suitable length with terminal ends fitted to suit disconnecting-boxes should always be kept with it ready for use. If the fittings in disconnecting-box are clean and of good design the time of connecting up only occupies two or three minutes. The resistance of bank of lamps is recommended, because at night the light is useful, and the test current can easily be varied by the removal or addition of lamps. It is essential that reliable instruments be used, and readings noted accurately as upon this the success of the test entirely depends.

The check test No. 2 usually confirms test No. 1, but should they differ considerably it is a sure indication that there is more than one "fault" on the cable—fortunately a rare occurrence.

Notes on the Equipment of the Meter and Testing Department of a Central Station.

By H. R. MOTT, A.M.I.E.E.

Superintendents of the Meter and Testing Department will agree that at many, if not most central stations the arrangements for carrying on this work are inadequate to its proper performance, and out of all proportion to its importance. Insufficient staff, unsuitable quarters, and inferior instruments are too often the rule. No argument is needed to enforce the importance of accurate testing, and this,

No. 1.	Date.	Length of Mains.	Sizes.	Calculated Distance of Fault.	Actual Distance of Fault.	Cause.	Time commenced to Locate.	Time Located and Tested.	Time Cleared.
		Yards.	Sq. in.	Yards.	Yards.				
1	16/8/04	84	.06	50.6	51	Moisture	12 midnight	2.15 A.M.	5 A.M.
2	16/8/04	161	.2	102	101	,,	4 A.M.	8 A.M.	10 A.M.
3	16/8/04	150	.06	½	on lug of box	,,	10 A.M.	1.30 P.M.	3 P.M.
4	17/8/04	145	.1	120	121	,,	10.30 A.M.	1.30 P.M	5 P.M.
5	22/8/04	150	.1	90	90	,,	10 A.M.	1 P.M.	6 P.M.
6	24/8/04	122	.2	3.47	3.3	blow from pick	1 P.M.	3 P.M.	6.30 P.M.

in an unsuitable or badly equipped building is difficult if not impossible. The author will in these notes deal first with the work of the department, next with its equipment for both meter and general testing, and finally with its staff.

The Department. Its Work and Equipment.—For the sake of having some definite grounds to work on, we will assume that the department is being fitted up to deal with 80–100 meters per week, in addition to the other work usually undertaken; we will also assume a direct current supply, briefly indicating at the end the alterations necessitated by an alternating current. The work will, in all probability, consist chiefly of meter testing, fixing, inspecting, repairing, and reading, but also of testing instruments for station use, lamps, new electrical plant, and occasionally faults in mains.

Rooms or Building.—If funds allow, a separate building should be arranged for. In any case the test rooms should be on the ground level, and as far away from the engine-room as possible so as to be fairly free from vibration. They should consist of the following rooms: Meter store and store-keeper's office, meter test room, instrument, lamp and general test room, meter cleaning and repairing-room, chief's office, meter readers' and clerks' office and battery room (as near to the test rooms as possible).

Equipment of Rooms.—The stores for tested and untested meters should be near the test room for convenience in handling the meters, and should be next to the entrance if possible, having a small space by the door partitioned off, and the door leading from this to the rest of the stores should be kept locked so as to prevent any one but the store-keeper or his assistant from touching the meters in the room. This partition is best fitted with a couple of sliding panels for the issue of meters and there should be a good broad ledge about 3 ft. 6 in. from the ground under the sliding panels both inside and out extending for about 3 ft. on either side of them, for resting meters on whilst taking numbers, &c. The store-

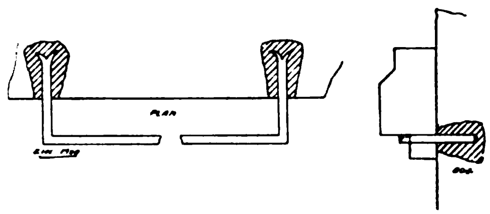


Fig. 1.

keeper's desk and shelves for books must be immediately inside the partitioned off space. One side of the room should be provided with racks capable of holding 200–300 tested meters; the other side and end can be kept for the untested stock, whilst a good strong bench in the middle of the room on which to seal up and number the meters is a great convenience. The form of racks will vary considerably with the kind of meters used. For the L.C.C. pattern of Thomson meter, nothing is better than angle iron let into the wall as Fig. 1, the terminal boxes of the meters simply being dropped in between the wall and angle iron. Ferranti, Hookham, and similar meters only need shelves to stand on, whilst Arons, Vulcans, Wrights, O.K.s, &c., are best stored on some battens fixed to the walls, with round-headed screws in them for hanging the meters on. The rest of the available space should be fitted with good-sized lock-up cupboards for tools.

Meter-Testing Room.—This must be a well-lit room about 18 ft. by 40 ft. and should preferably have a row of windows all down one side and if possible, a sky-light the greater length of the room. It will require to be fitted with test benches, instruments, resistances, &c., as described below. The testing-benches will, of course, vary with the kind of meter used, but the most generally useful type is that shown in Fig. 2 which is fully dimensioned, and as shown will take a test of six meters. These benches are best made of good well-seasoned teak, and two should be placed back to back with about two inches between, making a double bench

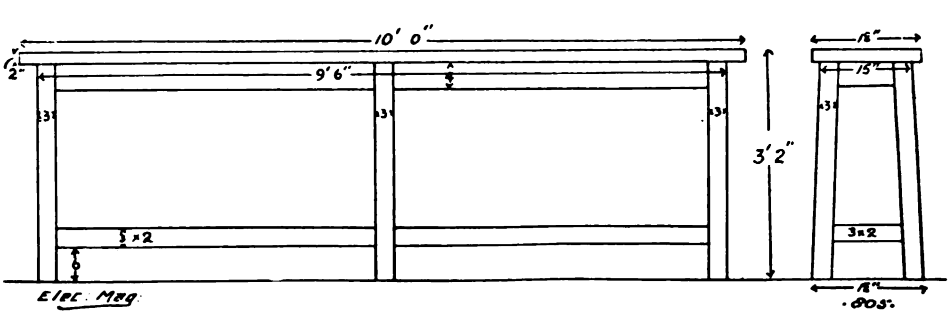


Fig. 2.

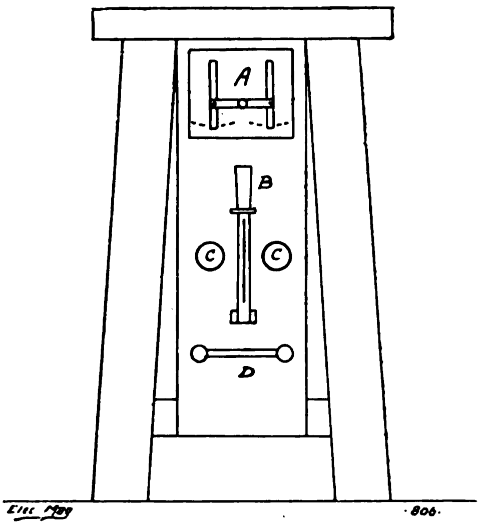


FIG. 3. TABLE SWITCHBOARD (NOT TO SCALE).

holding twelve meters. Two tables arranged in this manner will be found far superior to one single table of double width, as meters can be taken down or put up on one side without shaking those on test on the other. Each table should be provided with a switchboard as shown in Fig. 3, where A is a double pole voltmeter switch for the shunt circuits, B switch for main circuit, C.C. shunt circuit fuses, D. main fuse. The switches if with slate or porcelain bases may conveniently be mounted on a polished teak base which in turn is screwed to one end of the test table as shown. Two of these double tables will be sufficient for an output of from 80–100 meters per week.

Should the meters used be of various types, the stand shown in Fig. 4. will be found most convenient. It is a modification of the stands used by the British Thomson Houston Co. and is capable of holding all the most usual makes of meters as well as ammeters, voltmeters, &c. The modification consists of the detachable upright A, which makes it possible to use other than Thomson meters on these stands. They should be arranged on the tables so that their centres are at least eighteen inches apart, and the points of the levelling screws should rest in No. 14 brass sash burrs let in flush with the table top. If the meters used are only of the Aron, Wright, or similar types that can be hung up, then battens screwed to the wall, with round-headed screws for hanging the meters on, and a similar batten to take the bottom screws of the meters are all that are needed. If of the Hookham, Ferranti, or any similar type that will stand up, strong teak shelves with holes in them through which the mains can pass will be found most satisfactory. The benches as above described are best placed with one end against the wall in which are the windows, with sufficient space between each pair to allow of free movement when both adjacent tables are being used ; about six feet is enough. Coming now to the instruments for calibrating the meters, Kelvin balances will be found the best all-round instruments (A potentiometer can, of course, be used, but although of a larger range is not nearly so convenient in use). As probably both watt and ampere-hour meters will be used the best selection of balances will be approximately ; 1 watt balance 0–50 a., 1 watt balance 0–120 a. (both having suitable shunt resistances for the pressure used), 1-10 a. ampere balance and one 50 a. ampere balance. (Larger meters are best tested with the potentiometer, for which see general test room.) Unless it is intended to employ some one specially for regulation purposes, these balances

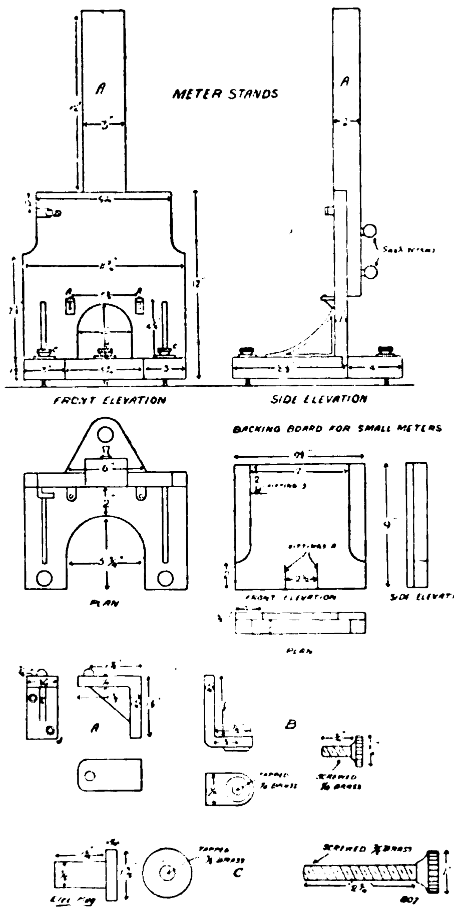


FIG. 4.

should be so placed that any one sitting at the test tables can easily see them and regulate while testing. They should stand on 3-in. teak shelves resting on 4-in. by 6-in. bearers let into the wall at such a height that the scale can be comfortably read while standing. A small locker to take the boxes of weights should be fitted just under the shelf. In addition to the above, several volt and ammeters will be required of various ranges. If the meters are to be checked occasionally on circuit some portable wattmeters will also be needed.

A galvanometer and bridge with the necessary keys, batteries, &c., arranged both for copper and insulation resistance will also be needed. The question of suitable resistance is one of the most difficult of all to settle satisfactorily. The author has found that a combination of carbon resistances, composed of cut carbon plates compressed by means of a screw, and wire resistances is the best solution of the difficulty; the carbon resistances being used alone for moderate currents and in parallel with the wire resistance for large currents, the carbon then being used as a fine adjustment. The best form of wire resistance is undoubtedly that shown in Figs. 5 and 5A. As will be seen it consists of four sets of ten single wires each of equal resistance and so arranged that any one wire will carry double or more than double the current of any one wire in the next set lower. A convenient set is one having

Ten wires each carrying		5 amperes		50 a.
,,	,,	15	,,	150 a.
,,	,,	20	,,	200 a.
,,	,,	40	,,	400 a.
		Total	.	800

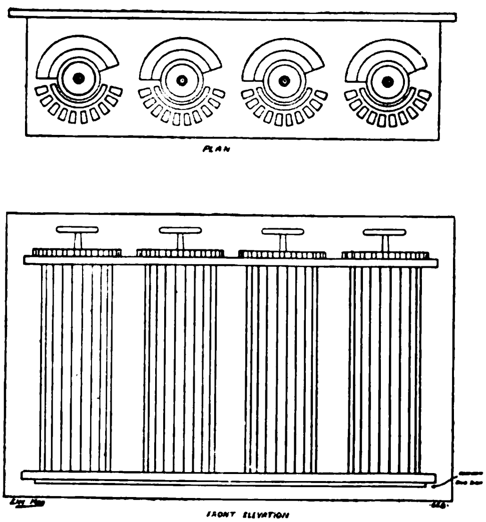
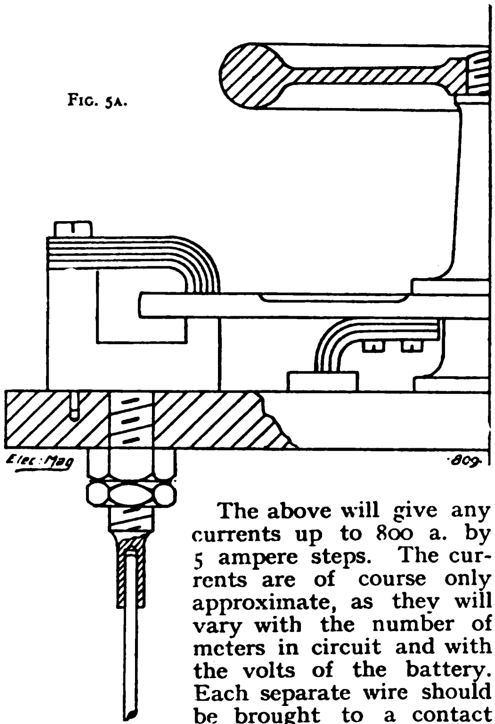


Fig. 5.

Fig. 5A.



The above will give any currents up to 800 a. by 5 ampere steps. The currents are of course only approximate, as they will vary with the number of meters in circuit and with the volts of the battery. Each separate wire should be brought to a contact piece and the moving arm of the switch is a plain sector capable of covering all the contact studs thus putting the wires in parallel one at a time.

The mains from the source of supply to the test benches are best run in concentric cable of sufficient size to carry the largest current likely to be used, and should be run in a culvert along the centre of the test-room floor with branches to the balances, resistances, and tables, and covered in with a cast-iron cover plate, so as to be easily accessible for additions or alterations. Some form of switchboard will be required for making connections between the test tables, instruments, resistances, and battery. Fig. 6 shows a suitable type which is self-explanatory. A desk and some chairs will complete the equipment.

General Test Room.—This should also be large and well lit, except one end which may be screened off for lamp-testing.

This part of the room should be about 12 by 8 ft. unless it is intended to measure the candle-power of arc as well as of incandescent lamps, in which case it must be 16 or 20 by 8. The fittings will consist of a photometer bench, various resistances, ammeters, voltmeters, and wattmeters for measuring the current, power, &c., taken by the lamps. The rest of the room should be fitted with benches on which instruments for test can be stood. These may

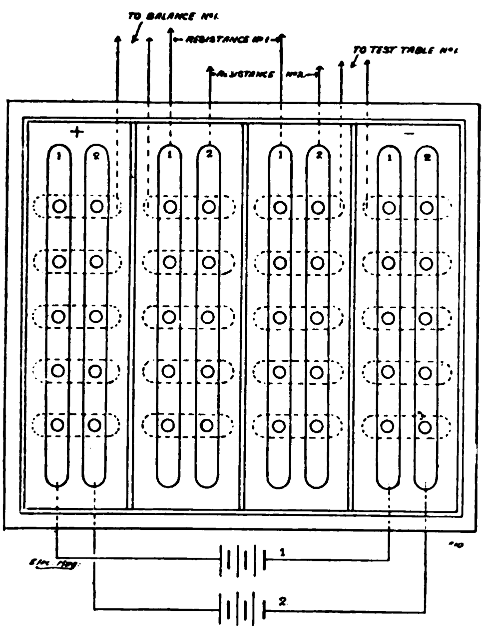


Fig. 6.

conveniently be the same as those in the meter room but without the meter stands and sash burrs.

Down one side of the room a beam might be run about 8 ft. from the floor, on which arc lamps can be hung when being tested for feed and adjustment. At the opposite end to the photometer a good firm bench should be provided for the standard instruments used in the calibration of the others. This bench ought to be of such a height that it is convenient for both sitting and standing at. Its top should be of teak at least $2\frac{1}{2}$ in. thick, and the legs about 4 in. by 4 in. spaced every 4 or 5 ft. If it is constructed as heavily as this there is not likely to be any trouble with vibration.

The instruments to be provided will, of course, vary with every department according to the work but the following may be taken as a fairly representative selection Potentiometer with shunts carrying up to say 1,500 amperes; volt-box, galvanometer, Clark cells, &c.; Kelvin balances (Watt) for quickness in checking portable wattmeters, standard voltmeters and several volt and ammeters for general use. A portable set for copper and insulation tests is also useful, and if main faults are to be tested an ohmmeter and some form of slide bridge suitable for this purpose will be required. If it is intended to hire out motors to consumers, a brake dynamometer for testing the horse-power becomes a necessity. The most satisfactory is the tripod form of Messrs. Nalder and Saomes. A speed indicator must also be supplied. The potentiometer is best arranged on a firm table which is screened on three sides and on top by curtains so as to keep off most of the light. In this way the rest of the room need not be darkened, while the galvanometer spot can still be seen quite clearly. The table can be fitted underneath with cupboards to hold the shunts, &c., so that no space need be wasted. This room as well as all others should have cupboards wherever possible.

Battery Room and Source of Supply.—The source of supply will, in all probability, be a secondary battery and this should be of such a capacity that it will discharge for a short time at 50 per cent. more than the *probable* maximum demand. The number of cells required will depend on the number of meters tested at once and on the length of mains between the battery and meters. It will be found a great convenience if this battery is in duplicate so that one can be charged while the other is in use. In this case the cells might be of rather smaller capacity, as in the case of an occasional heavy discharge, they could be used in parallel. The supply for the shunt or pressure circuits can either be taken off the supply direct through suitable resistances, or, what is better if the expense is not objected to, from a battery of a large number of small capacity accumulators,

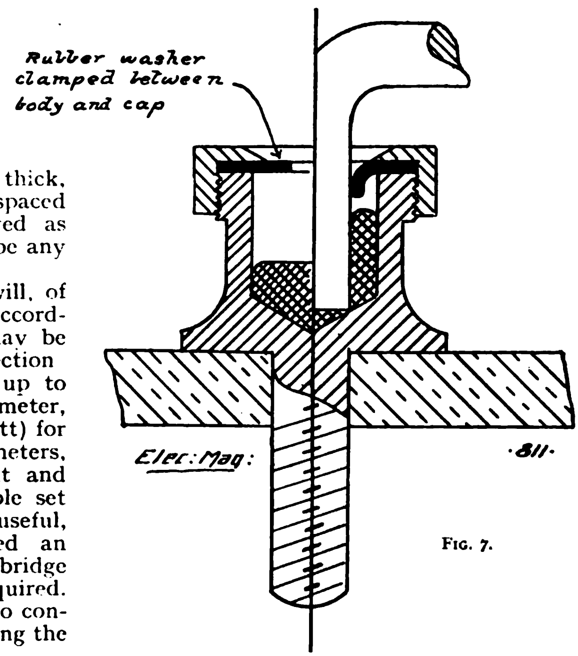


Fig. 7.

which will also be useful for insulation tests, &c. For charging the main battery a small rotary convertor or motor generator will be required, while the small cells can be charged direct off the supply through lamps or resistances.

The connections to the main battery must be arranged so that the cells can be used either in series or parallel, or combinations of the two. For this purpose there is nothing so generally convenient as a mercury switchboard, though mercury is horrible stuff for creeping, and ought to be as far as possible kept out of any self-respecting test room! However, mercury cups made as Fig. 7 (which shows one half empty and one half with connector in, illustrating the use of the rubber sheet) are fairly good, the rubber cap wiping the connectors as they are removed and preventing the mercury from splashing over. The board must be kept well away from the cells, as should any mercury get into them the effect will not be improving. The small cells are best kept permanently connected in series for the maximum pressure required, tappings being taken off for the other pressures and connected direct to the D.P. voltmeter switches on the test tables. Both sets of cells should be kept in a cool well-ventilated room as near as possible to the test rooms.

Meter Cleaning and Repairing-Room.—This should be a moderate-sized, well-lit room with racks round three sides for storing meters waiting for cleaning or repairs. Along the window side of the room can be placed benches of the size and shape shown in Fig. 8, of which three will be sufficient for a department of the size under consideration. These are for the men cleaning meters and each man should be provided with a separate bench. Cupboards for tools and meters and instruments undergoing repairs are also essential to a well-equipped room. If, as will probably be the case ground space is scarce, this room may conveniently be over the meter stores, communicating with it by means of a small lift for ease in handling the meters.

Chief's Office.—The chief's office like the meter-cleaning room may be over one of the others, and need only be of moderate size. One end should be partitioned off for the private clerk. The fittings do not need any special description being the usual complement of desks, stools, book racks, &c. The room should however be in communication with all the others by means of a telephone.

Meter Readers' and Clerks' Office.—This room like the last does not require any special attention, being only fair sized and well lit, and with the necessary supply of desks, &c. It may like the last two, also be over one of the test rooms.

Staff.—The Staff for the Department would approximately consist of the following:

(*a*) Chief-in-Charge who is responsible for the whole work of the Department to the chief engineer of the Company or Corporation only.

(*b*) Chief Assistant who will undertake any special tests that may be needed and who when not so engaged will assist in meter testing and the general work of the department.

(*c*) One or two junior assistants for meter testing. The workmen required will vary according to the range of work, but if the department undertakes, as it should do, the whole of the work connected with meters, *i.e.*, testing, fixing, keeping in repair and reading; they should be about as follows.

(*d*) Two men for putting up and taking down meters in the test room.

(*e*) Store-keeper in charge of meter stores and his assistant for sealing and numbering meters.

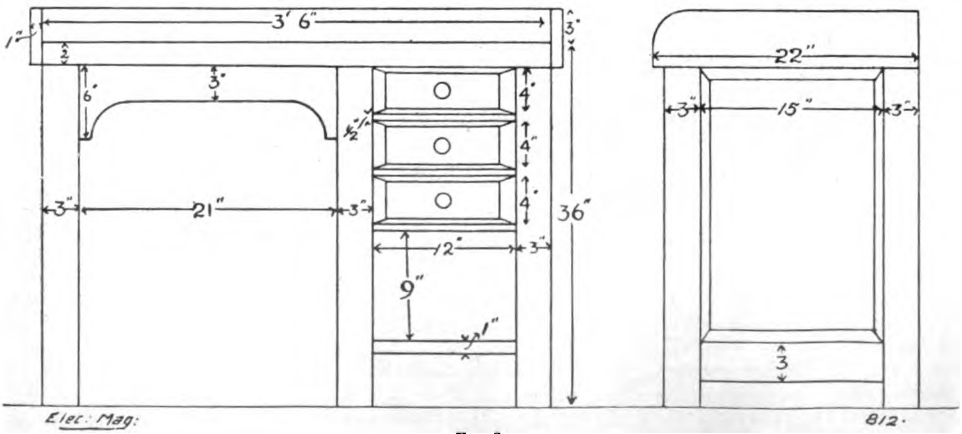


FIG. 8.

(*f*) One man as general help in instrument room.

(*g*) Three men for meter cleaning and repairing who can also assist in meter fixing and reading at busy times and who can be employed in cleaning meters out on circuit.

(*h*) Four men and their mates for meter fixing and changing; these can also assist in meter reading at the quarters.

(*i*) Six meter readers and one private clerk for the Chief's office.

Necessary Alterations for Alternating Supply.—The alterations necessitated by the use of an alternating supply are not numerous and are chiefly confined to the regulating resistances and some of the instruments. Let us here emphasise the fact that to attempt to test meters on alternating current with low pressures on the main circuits as with direct current, is very unsatisfactory as only one or two meters can be tested in series without getting a considerable power factor. It has been the author's experience that nothing under 50–100 volts is satisfactory in practice, and the use of a low-voltage transformer (except in special cases as below) is for the above reasons to be avoided, especially with small size meters whose main coils have an appreciable resistance, these being tested with the supply pressure for which they are intended.

For the very large size meters which are only wanted one or two at a time, the step-down transformer may be used and is a considerable saving, and one giving say 300–600 amperes at various pressures of from 2–10 volts will be found useful. The pressure for the shunt coils will of course in this case be taken from a pressure coil wound on the same transformer. The use of main currents at these higher pressures will necessitate an alteration in the resistances used, and for this purpose nothing has been found better than the type devised by Professor Fleming and described in his "Handbook for the Electrical Laboratory" (vol. i.). For testing the larger meters with the transformer above described, the wire resistance mentioned in the description of the test-room fittings can be used, as, if made of single uncoiled wires it is practically non-inductive. The ammeters used will have to be of special type for alternating current as will the volt meters unless Electrostatic. The potentiometer will of course be useless. If alternating motors are to be hired out some additional wattmeters for testing them will be required in place of the ammeters and volt-meters used with direct current.

Boiler Feed Waters, their Composition, Action, and Treatment.

By FRANCIS H. DAVIES.

The deleterious action that some waters have upon the plates and tubes of boilers is of course well known and appreciated. All engineers are only too familiar with pitted surfaces, and scale, the removal of which calls for all the art of the "boiler scurfer." But these troubles may in almost all cases be minimised by the installation of a good water softening system, designed, as far as chemicals or reagents are concerned to suit the special requirements of the water. A careful analysis should be the base of the proceeding, as that alone can show the nature and proportions of the undesirable impurities that cause the trouble.

The principal scale formers found in water are bicarbonate of lime, sulphate of lime, and magnesia. The former gives to the water what is known as temporary hardness, and upon boiling is precipitated in the form of carbonate of lime, the extra molecule of carbonic acid gas which holds it in solution being driven off. The two latter, in conjunction with certain chlorides and nitrates of lime and magnesia in proportions varying with the quality of the water, give to it what is known as permanent hardness, which unlike the former, is not precipitated at boiling-point but requires a higher temperature, or the addition of some such chemical as sodium carbonate.

From the point of view of scale formation it is obviously undesirable to allow this precipitation to take place in the boiler. A boiler fluid does not prevent it, but simply causes the precipitate to be soft and so easily scraped away. There are, however, limits to the capabilities of boiler fluids, and in any case scraping away costs money, so it is evidently desirable to get as much as possible of these impurities out of the water before feeding it into the boiler. This is the function of the water softener, the various makes of which all attain the same end, more or less successfully, by the same fundamental methods, differing only in their application and detail.

For the moment, leaving the reduction of temporary hardness by boiling out of the question; it was found many years ago that the addition of hydrate of calcium or slaked lime in proper quantities resulted in the precipitation of the carbonate of lime by the same action as boiling, viz., the driving off of the carbonic acid gas which holds the latter in solution. The lime is also precipitated being converted to

carbonate by the carbonic acid it absorbs. The chemical change is expressed thus:

Bicarbonate of lime.		Calcium hydrate.	Carbonate of lime.	Water.

$$CaCO_3 + CO_2 + CaOH_2O = 2CaCO_3 + H_2O$$

A certain percentage of water is set free from the hydrate of calcium and accounts for the H_2O in the above equation.

In plain words the action is this: Bicarbonate of lime is soluble in water and therefore does not precipitate. Carbonate of lime is only very slightly soluble and therefore *does* precipitate. If plain lime is added it at once takes away the extra molecule of CO_2 from the bicarbonate converting it to carbonate, and by the absorption of this extra molecule turns itself into carbonate and precipitates along with the original impurity. The result of the equation, $2CaCO_3$, or two atoms of carbonate of lime, shows this.

While this process does very well and is greatly used for the reduction of temporary hardness, it is quite ineffective where sulphate of lime or permanent hardness occurs, and the eradication of this is usually performed by the addition of carbonate of soda Na_2CO_3. The resulting equation is:

Lime sulphate.	Soda carbonate.	Lime carbonate.	Soda sulphate.

$$CaSO_4 + NaCO_3 = CaCO_3 + NaSO_4$$

which shows that carbonate of lime is formed and deposited as before plus sulphate of soda, which being very soluble, is not deposited but left in solution with no bad results as it is not a scale former, and occasional blowing down suffices to prevent its undue accumulation, crystallisation, and consequent injury to the plates.

This sulphate of lime forms a most obdurate scale, the reason being that it precipitates in the form of small angular crystals which mix with the comparatively muddy deposit of calcium carbonate, and become considerably heated by contact with the furnace plates. This causes them to lose the water of crystallisation and assume a needle-like shape, which suffices to bind the mixture closely together and so form a very bad incrustation.

The greater the heat the deposit is subjected to the harder it becomes, for example, it will always be found most obdurate on the crown of the furnace where the heat is at a maximum.

A method of scaling that recommends itself by its simplicity and cheapness is the following:

The boiler to be cleaned is blown down, scrubbed out with hot water, and allowed to dry. The hard deposit is now sprayed with petroleum which it absorbs, and the boiler is filled again and put to work.

After a short time, if it is opened out, the scale will be found to have flaked off, or at any rate to have become loosened so much that it may be easily removed: and it is conjectured that the reason of this is, that upon heating, the petroleum that has been absorbed vaporises and expands and in doing so, forces the scale away from the plates. If the scale is too hard to suck up the petroleum the method must fail, but with deposits of a moderate hardness it has been found very successful.

To return to the question of the chemical treatment of water impurities; the two cases instanced before this digression are simple inasmuch as there is presumed to be only one or the other form of hardness in the water. When both occur, other treatment is necessary, and many years back the late Dr. Angus Smith in a report to the Manchester Steam Users Association demonstrated that provided the proportions of the two lime salts were known, the addition of caustic soda would have the effect of rendering both impurities insoluble and so capable of deposition. In this case the caustic soda takes up the carbonic acid from the bicarbonate of lime which is thus precipitated in the shape of carbonate as before; but by the absorption of the CO_2 the caustic soda becomes carbonate of soda, which now exchanges acids with the sulphate of lime, and as shown above deposits carbonate of lime and leaves sulphate of soda in solution. The reason for the desirability of knowing the relative proportions of the two hardnesses is, in order that the correct amount of caustic soda sufficient to produce carbonate of soda to react on the lime sulphate, may be ascertained. Unfortunately caustic soda at about £11 a ton is apt to prove rather an expensive item, it is therefore usual where both impurities are found, to treat for each separately.

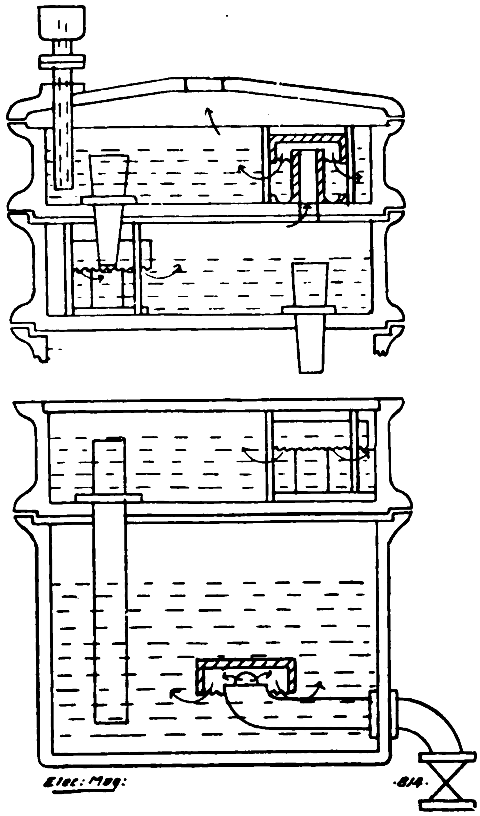
There are sundry other chemicals found in waters that require special treatment: a very bad one magnesium chloride is fortunately not of frequent occurrence: it is very unstable, and at high temperatures turns into magnesia and hydrochloric acid with the dangerous result that the boiler plates are quickly corroded. Plain salt is said to be a remedy as it prevents this change to a certain extent. Gypsum, an impurity that forms a very hard scale at high temperatures is rarely found in large quantities, but may be successfully treated by barium chloride and milk of lime.

In places where a water softener is supposed to be too much of a luxury, many what may be termed homely methods of preventing scale formation are found in use; for instance the encrusting action of water containing carbonate of lime may be nullified by the insertion in the boiler of various woods and barks such as logwood

and oak, or others which contain tannic acid; and vinegar and sugar have also been used owing to acetic acid being present in their composition. Both these acids especially the last are however very injurious to the iron of the boiler, and no matter how efficient they may be in preventing the formation of hard scale, are for the above reason certainly not to be advised.

Refined petroleum has been found effective in water containing a large proportion of lime sulphate, and there are many other receipts of this kind that claim to deal effectively with waters of various compositions and degrees of hardness. On the whole, however, they are to be avoided; if the water contains scale forming impurities to an objectionable amount, it is better by far to remove them before feeding into the boiler by the aid of a proper softener.

These may be divided into three classes: (1) those that precipitate out of the impurities both temporary and permanent by the addition of chemicals; (2) those that use heat for the reduction of the first and chemicals for the second; (3) those that use heat for both.



Chevalet-Boby Heater Detartariser.

The first class in its simplest form would consist of a tank in which the chemicals and water are mixed, the deposit being allowed to settle at the bottom and the feed water drawn off at the top. Such a primitive method however for obvious reasons would be impracticable, and softeners of this type usually contain a mixing tank, where the chemicals and water from the main are intermingled, a settling tank, to which the above mixture flows and where most of the impurities are deposited out, filtering tanks, where any residue is disposed of, and a large storage tank that compensates for the slowness of the process.

The admission of the reagent is often effected automatically in quantities in proportion to the amount of water passing through the apparatus. As the latter enters the tank it operates a small water wheel, the speed of which varies with the amount of water; this actuates the lime feeding device and regulates the supply.

To treat anything but the smallest quantity of water, this system in its crude form necessitates very large and deep tanks, obviously an objection as space is generally a consideration; but this difficulty has been met by providing means for constantly stirring the mixture and so forcing the lime particles into intimate contact with all parts of the water.

Without some such arrangement the action can only take place by the sedimentation of the lime, which is of course a lengthy operation.

In the Archbutt Deeley process the mixture is agitated by means of air injected through perforated pipes laid in the bottom of the settling tank. After a short time the agitation is stopped and the residue allowed to settle, the water being drawn off at the top. Besides the usual reagents sulphate of alumina is sometimes added to assist the precipitation of organic matter such as is found in river water polluted by sewage.

Even with the most perfect settling and filtering arrangements there is always the possibility of a small quantity of the precipitate remaining in the softened water, with the result that pipes and fittings are liable to become choked.

The Archbutt Deeley process provides for this by the addition of a recarburator, the function of which is to supply sufficient CO_2 to the softened water to allow the remaining salts to become soluble, this being effected by blowing the fumes from a small coke fire into the water by steam jets.

The second class is exemplified by the Chevalet-Boby Heater Detartariser: here the temporary hardness is deposited out by boiling, and the permanent by the

addition of carbonate of soda. It is based upon the facts that for the precipitation of $CaCO_3$, the boiling must be continued for some time, and the water must be well broken up or pulverised to assist in the escape of the gas. The reagent is forced into the top chamber of the softener by a small pump which is fixed to and actuated by the feed pump so that each stroke of the latter delivers a known and proportionate amount of the reagent to the detartariser. Here it meets and mixes with the crude water, the whole being constantly stirred up by the bubbling action of the steam which passes upwards from section to section by the aid of special vents, forcing its way through the water and maintaining it at boiling-point all the time it is in the apparatus. The water passes by gravity through overflow pipes into each section in turn, finally arriving at the receiver at the bottom in a softened and boiling condition.

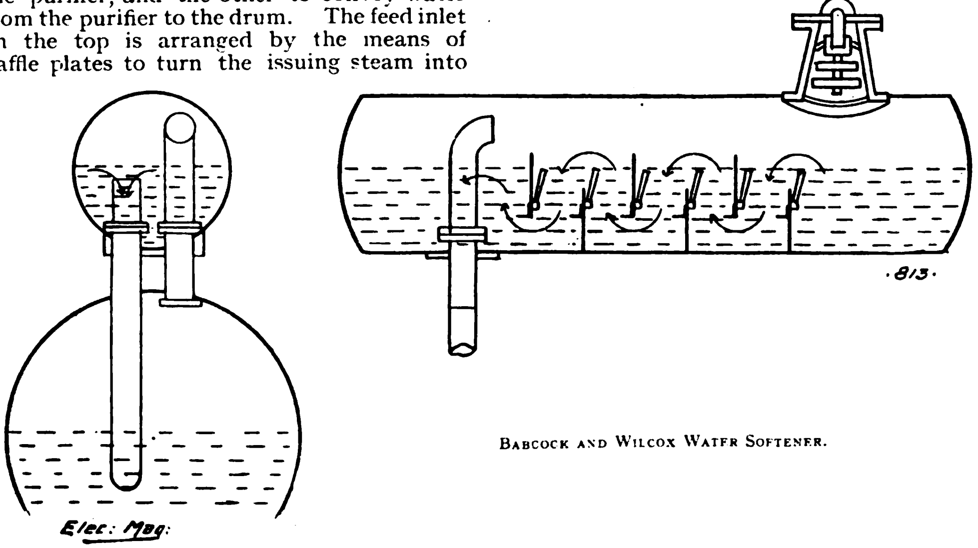
Wherever possible exhaust steam is used, but as in passing through the water it is nearly all condensed and returns its heat to the boiler there is practically no loss, so that if enough exhaust steam is not available the balance may be made up of live steam without inefficiency.

The third method, that which employs heat only for the reduction of both forms of hardness, is the one used by Messrs. Babcock and Wilcox. Its action depends upon the fact that although calcium sulphate is not precipitated at boiling-point, a temperature of upwards of 320° will produce this effect, at the same time of course depositing the carbonates. The apparatus is cylindrical in form and is fixed to the top of each boiler. Two pipes enter it from the drum, one being used to convey steam to the upper part of the purifier, and the other to convey water from the purifier to the drum. The feed inlet on the top is arranged by the means of baffle plates to turn the issuing steam into a spray, and in this form it passes through the steam space and falls to the bottom of the cylinder at one end. The outlet for the water being situated at the other end it has to pass along the purifier, and its course is made tortuous by the aid of further baffle plates fixed from side to side, and so arranged that the water passes alternately over and under them. This results in the precipitation of the impurities on the plates, and only soft water reaches the boiler drum.

At the high temperature at which this apparatus works, the calcium carbonate is deposited almost immediately, but the calcium sulphate takes a rather longer time.

It is well known that the presence of oil in a boiler is highly undesirable, and for this reason it is most essential that all traces of it should be removed from the feed water before it is pumped into the boiler.

Where surface condensing obtains, and the water is used over and over again, oil from the cylinders and piston rods is sure to get into it, unless preventive measures are taken, and these must be very thorough indeed if they are to be effective. The use of a grease separator in the exhaust main is essential, as an efficient one will remove the bulk of the oil from the exhaust steam. This piece of apparatus generally works by deflection, impact and reduced velocity; that is to say the exhaust steam containing the oil is suddenly deflected at a right angle as it enters the separator with the result that the inertia of the oil particles carry them on in a straight line to be deposited on the side of the bend, and so drop down to the reservoir. The impact of the steam and the remaining portion of oil on the contents of the reservoir now shakes out



Babcock and Wilcox Water Softener.

some more of the latter, and as the area of the separator is much larger than that of the pipe, the steam now expands, loses a lot of its velocity, and for this reason is to a great extent rendered incapable of carrying many of the comparatively heavy oil particles up to the top of the apparatus where it gains exit.

The residue is pumped out of the receiver and after the water is separated from the oil the latter can be used over again.

The essential point in installing a grease separator is to see that it is large enough for its work; where this apparatus has failed it has invariably been too small. Although some makers claim that all the oil can be extracted by the above means it is best to make assurance doubly sure and instal in addition some form of filter, either before the condensed water reaches the feed tank, or in the delivery of the pumps. In the former case a series of filters consisting of small tanks filled with powdered coke or sawdust may be employed but this is scarcely as satisfactory in results or convenience as the latter, the Turkish towelling or cocoa-nut matting of which forms a very efficient filter if kept clean. Any filter in the pump suction, that is between it and the feed tank is a mistake, as in this position it must seriously reduce the flow of water if efficient, and being under no pressure to speak of cannot be doing duty properly if it allows free passage.

The objections to the presence of oil in feed water are manifold; firstly, the thinnest coating on the plates or tubes of a boiler causes a serious diminution in their powers of transmitting heat, and an oily deposit that is thick enough to be measured will surely lead to overheating and explosion. Again, tallow, which forms a great part of many cylinder oils contains stearic acid and glycerine, which when boiled up in the presence of soda is decomposed into stearic acid on the one hand and soap on the other and the former although weak and greatly diluted will make its presence known sooner or later by pitting and general corrosion. It is safe to assert that a good percentage of boiler explosions are primarily caused by the presence of oil in the water, and where this becomes evident, no time should be lost in providing efficient separating or filtering arrangements.

The rusting and pitting of boilers other than that due to oil, is best considered under two headings: (1) When the boiler is standing idle; (2) When working. Usually a boiler forms one of a battery, and is of course occasionally laid off with its stop valve and possibly others between it and the working boilers, closed. But no valve is perfect, and steam in larger or smaller quantities is bound to get through, in which case it condenses on the top of the boiler and causes bad fitting there in time. If a boiler is to be left standing for any considerable period it should be blown down when hot, as it will dry at once and no harm will occur. If it is not blown down until cold, a draught of air should be passed through it, or, hydroscopic bodies placed inside or else it may be painted internally with some alkaline coating, such as milk of lime or cement. Another method is to fill the boiler right up with pure water, but this must have all air removed from it or it will be of no avail.

In short to prevent pitting when a boiler is standing it is necessary to totally exclude either air or water: if both are present and are allowed to touch the iron they will act in conjunction and corrode it.

The most important cause of rusting when a boiler is working is the presence of air in the water. If the feed-pipe is properly placed, that is so that the water enters the boiler close to the low-water level, the air that it contains is quickly expelled by the heat and passes away with the steam; on the other hand, if the pipe is higher, it will form in bubbles on the upper surfaces and cause pitting. Good circulation is in a way a remedy for this as it removes the air bubbles as fast as they are formed. When a boiler is fed with cold water, free oxygen enters it in the form of an hydrate and immediately attacks the plates forming rust which scales off leaving a fresh surface to be acted upon. This process continues until finally the plates become thin and dangerous, and if blackish red particles of scale are found in the mud at the bottom of the boiler, it is time something was done as this is a sure indication of the presence of free oxygen.

Electrolytic action is another cause of pitting. Frequently minute particles of brass from air pump pistons and rods find their way into the boiler, depositing themselves on the iron and in conjunction with it setting up a little electrical couple of whicht he iron is the negative element and consequently suffers. The remedy for this is of course the old expedient of suspending zinc slabs in the water space and connecting them electrically by the aid of bolts or screws to the boiler. Both iron and brass are electro-positive to zinc so that now the latter only is affected. Lesser electro-chemical action goes on between iron and rust or ferric oxide; the latter is positive to the former which is therefore gradually eaten away and pitted.

The presence of organic matter in feed water is undesirable as it contains CO_2 which in itself is a corrosive and in addition assists the pitting action of oxygen by conveying it to the iron.

Electrical artisans should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles on subjects of importance to themselves.

"Principle or Humanity?"

By S. A. CURZON.

WHAT promises to be one of the greatest calamities that could have occurred to the London branches of the engineering trades in general, is the outcome of the decision of the Engineers' Society against the acceptance of time and a quarter for night work offered by Messrs. Yarrow. It is now common knowledge that the contract price and conditions obtained from the Austro-Hungarian Government for building torpedo-boats and destroyers did not admit of the Union demands being met. Had the time for delivery allowed for the work being carried out by day all would have been well, but it became necessary under the time-limit to employ two shifts of men. Messrs. Yarrow were open to pay time and a quarter, but the Union demanded their full London rate of time and a half for night work. Such an important point as has arisen here should not be dictated by a paper principle, but should have for the basis of any decision formed, the needs of the community at large.

We have at present a most severe labour crisis, and the winter directly ahead. At the most moderate estimate Yarrows would have employed 2,000 men for several months and, look at it which way you will, it seems that any principle that will prevent this number of men from earning a living—at wages which are at or above the standard rate—is indefensible. Now the point that should receive the close consideration of all workers in the engineering industry—electrical or otherwise—is, should one body of men be permitted to dictate to numerous others? The underlying principle when overtime rates were fixed does not apply here at all. When a man has done a day's work, and is asked to remain, then the overtime rate should operate, firstly as only a just recompense to the man, and secondly, as a check upon the individual, who by working extra time may be preventing another hand from obtaining employment. But here we should have a body of men starting work at night, and working the ordinary number of hours. The Society demand that one body of men should put in a day's work at ordinary rates, and another body should put in the same amount of time but receive time and a half for it. It would be well to pause and study these labour questions more thoroughly and without selfishness, before forming a decision that is so much against the benefit of trade in general. This winter will see many men drawing out-of-work pay from the Union, who, but for this decision, might have been earning good wages. Then there is the effect of this upon dependents. Scanty-fed and ill-clad will be the lot of many who should have been better placed. Whether it is legislation, Union rules, or anything else, the basis should always be—the greatest good to the greatest number

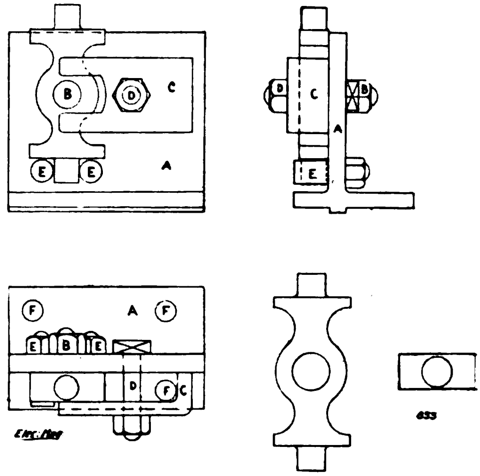
Another point that must not be missed is that the rate offered by Messrs. Yarrow is the one accepted all over the kingdom except in London. Why is the London worker worth so much more for his overtime than his provincial brother? The London Branch of the Amalgamated Society of Engineers is a most powerful body but there are others. Their decision in this matter affects many allied trades whose workers do not belong to this Union.

One would have thought that the last strike had shown the danger of sending work out of the country. When a normal state of affairs was resumed English engineers had lost a large amount of trade that has never returned. It seems more than probable that the Austro-Hungarian Govern-

ment will be placing other large orders shortly. After this will English firms get any chance at all? The point that the men have decided the question by ballot is very thin. Most of them vote according to the advice of their officials who lose no opportunity of schooling the members to the aims of the executive. It would seem to the impartial mind that the Society has overstepped the bounds of prudence. Had it been a question of working longer hours every one would have upheld them in standing firm for ordinary rates. But this is quite a different thing, and should be treated in a different way. The argument that the whole principle of wage rates is at stake and must be firmly adhered to is no defence. The principle that will prevent men from accepting work at a rate of pay agreed to all over the country, merely because they happen to be in London, and then deprives another large number of men from earning a living is altogether out of bounds. The electrical trade is not affected to so great an extent, but nevertheless, there is a probable loss in our industry over this matter, and we in common with many others have no voice in it at all. Such things as this are not calculated to improve the existing relations between masters and men—one of the things that all true labour workers endeavour to make as smooth as possible. Messrs. Yarrow will, when looking at the financial standpoint, chuckle at the foolishness of the men. They will probably make more profit through it. This is the second time that the Engineers' Society have tackled this point. Should a third occasion occur—which is extremely unlikely—it is to be devoutly hoped that a little more common sense and a little less "principle" will come to the fore.

FIXTURE FOR MACHINING DISTANCE PIECES.

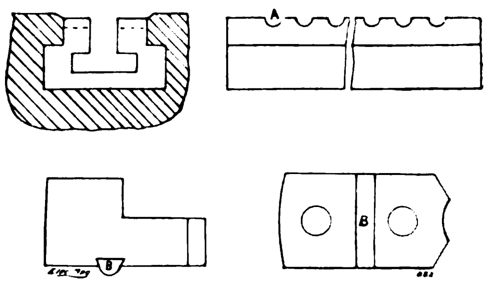
Having a large quantity of distance pieces to make in brass for some electrical machinery, with round ends as shown in the sketch, we at first decided to turn these in the lathe, but soon found that was too slow, we then made the rig shown in the sketch, and by its aid a boy can now do twenty-two per hour and make an accurate job of them as they require to be interchangeable. A is a cast-iron angle bracket planed on the bottom. B is a stud on to which the distance piece fits—being drilled first. EE are two locating pins which keep the work in position, these as well as the centre stud can be changed to suit different sizes of work, the latter being cramped up by the angle cramp C and bolt D, the ends are milled to size by an adjustable hollow end mill fixed in a drilling machine spindle, this being fed down by hand by a lever feed and quick return, a cramp stop is fixed on the top of drill spindle to act as a stop, the spindle is fed down until



this bears on the loss of bevel driving wheel, this ensures exact duplicity, and prevents any being made too small. W.D.

ON BORING MILL CHUCK JAWS.

Having a 30-in. "Bullard" Mill of the standard type with three jaws clamped in the slips, which are let into the table and operated by a pinion and scroll, and which we used largely for boring and turning motor pinions, driving pulleys, &c., after continued wear we had great difficulty in gripping work tight enough to operate on as the friction between the loose jaws and slips were not sufficient to prevent them from slipping. After trying various remedies, such as emery cloth, &c., between them, we took the three slips out and milled half round grooves across them as shown at A. We then cut a dovetail groove across the bottom of the three jaws as shown, and let a piece of steel into each



as shown at B. These were filed up on the bottom to be a good fit in A. After the jaws were tightened up in their places it was impossible for them to slip as the steel key held them secure, the grooves in the slips were $1\frac{1}{4}$ in. apart. Swift.

ELECTRICAL TRADE and COMMERCE

Trade and Commerce Articles of the month are classified under the World's Electrical Literature Section at end of Magazine.

The Mexican Market.

By W. NOBLE TWELVETREES, M.I.Mech.E., A.M.I.E.E.

ATTENTION has been called from time to time in the columns of THE ELECTRICAL MAGAZINE to the rapidly increasing industrial development of Mexico. Scarcely a week passes without the announcement of some new scheme of interest to manufacturers in general and to manufacturing engineers in particular. In spite of such reports, a good many people in the United Kingdom seem to think that it is scarcely worth while trying to secure business, owing to the proximity of the country in question to the United States, an impression which is industriously fostered by the jubilant publicity given by American trade journalists to the share of business that reaches their compatriots. British methods are less efflorescent, but the fact remains that the improvement of trade relations with Mexico has been most marked within recent years. For instance, in the year 1901–2, while the exports from the United Kingdom and British possessions amounted to £1,737,095, the figures for 1902–3 amounted to £2,244,090, an increase of £506,995. In the same two years the United States with undoubted geographical advantages, only showed an advance of £296,000. Recent official returns prove the fact that in almost every branch of trade we have fully held our own, and have considerably increased our exports of various products, and notably of electric lighting apparatus. There is every reason for believing that further attention to the Mexican market would amply repay all who are concerned in the electrical industries. At a time when American engineers and commercial agents are trying to capture every outlet for electrical machinery and apparatus, we certainly ought not to be content with the fairly satisfactory conditions at present prevailing. Some valuable hints on the subject may be gathered from the last report from the British Consul at Vera Cruz. In this document the opinion is expressed that "The present consumption of British goods is but a small percentage of the trade that might be done." Import houses are particularly lacking, and the opinion is expressed that the British merchant should return to compete further with Americans and Germans, and ultimately to re-establish his former predominance in the trade of the Republic. Much trade is lost every year because British advertisements are never seen in local periodicals, and British journals are not sent into the country, while American magazines and newspapers are everywhere. More commercial travellers are still wanted, correspondence with natives ought always to be conducted in Spanish, and prices quoted in the currency of the country. The latter condition applies to catalogues, wherein not only local coinage but also local weights and measures should be adopted. A remarkable fact is that in ten years the sale of American machinery has increased from £300,000 to £1,400,000, simply because it has been pushed chiefly by the branch houses of American firms. The British plan of appointing foreigners as agents is never likely to produce the results to be attained by direct representation. Another important point is that all orders must be promptly fulfilled, for only in this way can we successfully combat the advantages given by the proximity of the United States. In this issue we give brief particulars of two or three recent Mexican projects which are merely typical of many others on foot throughout the country, and we hope that some of our enterprising readers will find it possible to enter upon still more energetic competition for the business which at the present time is being diverted to other channels.

MONEY-SAVING HINTS FOR ELECTRICAL TRADERS.

IN a recent contribution to *The Electrical Times*, Mr. C. H. Watts, dealing with railway rates and charges, says that the indifference of manufacturers to rates for freight, and their apparent reliance

on the railway companies to charge them fairly, instead of taking the trouble to secure the cheapest terms, have been forcibly brought home to him when overhauling the accounts paid by several electrical firms. The purpose of the article in question is to show how railway accounts may be checked and a considerable saving thereby effected. The errors are of two kinds: (1) mistakes in entering weights and payments; (2) mistakes due to the variety of tariffs, and uncertainty as to which tariff should be applied to particular classes of goods. The writer then makes suggestions to the following effect. When forwarding goods the weight should always be taken and a record kept. When the account is received from the railway company the weight shown on the invoice should be compared with a copy of the advice note, and a note made thereon as to the date on which it was paid. This will serve the double purpose of checking the weight and ensuring against double payment. Having found the weights correct, the next thing is to examine the classification, as this determines the rate at which they are charged. All goods are charged according to their class, which ranges from 1 to 5, the higher class indicating the dearer rate. With regard to this classification it is said that no industry is so badly provided for as electrical engineering, not half the articles manufactured being mentioned in the classification book. It is very interesting, too, to see how those are dealt with which are recognised by the railway companies. For instance, electric arc lamps can be charged at two different rates, although the correct class is the third. This arises from their being described in the classification book as:

Electric arc lamps (excluding globes
  or carbons—in parts—3rd class.
Electric arc lamps—in parts—4th class.

Accumulators are charged second class even if they contain acid. Yet the acid, if sent separately, is charged fifth class, and the plates if described as lead plates for accumulators, are charged first class. The glass containing cell is charged third class, consequently when forwarding large numbers of cells it would pay to pack, consign, and describe the plates and glass cells separately, as no one sends accumulators ready for service. It is often the practice in despatching such things as volt and ampere meters, to describe them as electrical instruments. They should be described as *meters* only, and will then only be charged third class; unless this is done they will be charged fifth class. Globes for arc lamps should be described as common flint glass; if this be done a saving of nearly 50 per cent. will be effected, particularly if consigned at owners' risk. Dynamos or motors should not be described as machinery, which goes at the third or fourth class, whereas dynamos or motors are included in the second-class rate.

GENERAL TRADE NOTES.

Wolstanton and Burslem Workhouse.

PLANS have been approved by the Local Government Board for the electric lighting of the Wolstanton and Burslem Workhouse buildings.

Italian Telephones.

THE Italian Government has set aside a sum amounting to more than £50,000, to be devoted to the installation of telephone lines between Naples, Rome, and Turin.

Lighting at Linlithgow.

THE County Council have approved the contract for electric lighting systems to be installed in the villages of Broxburn and Uphall, and are about to negotiate a loan of £3,000 in connection therewith.

Foreign Electrical Products.

THE imports of foreign electrical goods during August are valued at £67,766, bringing up the total for the first eight months of the year to £502,265, as compared with £499,807 in the corresponding eight months of 1903.

Waipori Falls.

THE Bill promoted by the Waipori Falls Electrical Power Company has passed the New Zealand House of Representatives, and all the local authorities except the Dunedin City Council favour the supply of electrical energy to their districts by the company.

Workhouse Lighting, Ormskirk.

THE Board of Guardians are considering the question of installing independent electric lighting plant, and as the District Council contemplate establishing an electricity supply, the guardians have been asked to consider the question of taking current from the council.

Wisbech Electricity Scheme.

WE learn that Messrs. Robert Hammond and Son, have been retained by the local council as consulting electricians to advise as to the proposed municipal electricity undertaking. An application has already been made for sanction to borrow the sum of £25,000 in respect of the projected works.

Shanghai New Electric Tramways.

TENDERS are invited by the Municipality of Shanghai for the construction and working of twenty-four miles of electric tramways on the trolley system. Conditions, plans, &c., may be obtained on application to Messrs. Pook and Co., 63 Leadenhall Street, E.C., who are the agents for the Municipality of Shanghai.

Copenhagen-Iceland Cable.

IT is reported that the new cable from Copenhagen to Iceland will be completed next year. The connection will be made by way of the

Shetland Islands, between which and Scotland a cable already exists. The work is being carried out by the Great Northern Telegraph Company, of Copenhagen, at an estimated cost of 2,000,000 kroner.

Electric Transporter at Victoria Falls.

In the early part of August the operation of the new electric transporter on the cableway over the Zambesi River was commenced. This conveyor, which is to be used in connection with the construction of the railway bridge, is designed to carry a maximum load of ten tons, and is operated by a 30-h.p. motor, taking current from a bare copper conductor. The contractors for the cableway were the Cleveland Bridge and Engine Company, of Darlington.

New Sources of Rubber Supply.

The steady and increasing demand for rubber from the State of Bahia (Brazil) has resulted in the discovery of new sources of supply. Vast forests, the existence of which was never suspected, have been exploited, and a grade of rubber obtained far superior to anything hitherto seen on the Bahia market. The price varies from *2s. 4d.* to *2s. 10d.* per lb., cost and freight to the United Kingdom. The rubber is collected by the few natives who are not too lazy to undertake the task, and there appear to be no definite owners of the forests to which we refer.

Marylebone Electric Lighting.

The new generating station at St. John's Wood is now being erected. Mr. F. Wilkinson, late electrical engineer to the Walthamstow Municipal Council, has been appointed the resident electrical engineer of the Marylebone electric lighting works, with a salary of £600 per annum, and Mr. A. Wright, of Moorgate Street, is the chief engineer. Until the completion of the new station, current will be supplied to the district from the Willesden works of the Metropolitan Electric Supply Company, whose local property and goodwill has lately been purchased by the Marylebone Council at a cost of a million and a quarter sterling.

Electricity in Costa Rica.

An installation of wireless telegraphy on the de Forest system has been completed by the United Fruit Company in Limon to work in conjunction with a station at Bocas del Toro at a distance of sixty miles. The town of Limon has lately been lighted by electricity, incandescent and arc lamps being provided in the streets and on the wharves. The tramway and lighting departments of the San Jose Electric Light and Traction Company are both in regular operation, and a new and important waterpower, known as "El Brazil," has been acquired by the company with a view of extending their business to several districts in the vicinity of the town.

German Cable Extensions in Turkey.

After negotiations extending over two years, a concession has been granted to the German Telegraph Company for Eastern Europe for the laying and working of a cable between Kustenji and Constantinople. The capitals of Germany and Turkey will be connected by a special wire, which will probably be finally extended as far as the Persian Gulf and the Far East. It is stated that this concession will interfere with the preferential rights of the Eastern Telegraph Company, who some time ago lodged a protest with the Porte, and the company have already demanded an indemnity from the Ottoman Government, which, we understand, will be paid by the German Company.

Morris Turbines for Canadian Niagara Plant.

The award of the first contract for water turbines to be installed in the power-plant under construction at the Canadian side of Niagara Falls by the Toronto and Niagara Power Company, has now been made. The turbines ordered are four in number and of 10,000-h.p. capacity each. The contract has been undertaken by the I. P. Morris Company, of Philadelphia. These turbines will be direct-connected to 7,500-k.w. generators to be built by the Canadian General Electric Company. Mr. F. S. Pearson, of 29 Broadway, New York, is the consulting engineer for the Toronto Company, and Mr. W. P. Plummer, of the same address is the purchasing agent.

Openings in Italy.

There will shortly be an exceptionally good market for electrical machinery in Italy. By decision of the Italian Government, new telephone lines will shortly be laid between the following cities: Brescia-Bergamo-Lecco, Cremona-Piacenza, Genoa-Pisa-Livorno, Naples-Foggia-Barletta, and Naples-Reggio-Messina. Further the Privy Council of Rome is contemplating the construction of a tramline between Rome and Civita Castellana, the Adriatic Railway is studying a scheme for a line connecting Chiasso-Como and Chiavenna, the municipal council of Venice has decided to purchase a number of motor-boats, and lastly, the Adriatic Railway has been authorised to purchase 150 storage-batteries.

Electricity at Leeds.

Colonel A. G. Durnford, R.E., has recently held an inquiry at Leeds Town Hall for the purpose of considering the application of the corporation for sanction to borrow £100,000 for electric lighting. The town clerk submitted a statement of the progress of the electric lighting undertaking, from its acquisition by the corporation, which showed that the number of consumers for lighting purposes in September 1898 was 770, and in March last, 3,612. The number of consumers for power and heating purposes has increased from 6 in September 1898 to 376 in March last, the total number of consumers having increased in that period from 776 to 3,988. In September 1898, the number of 36-watt lamps, or equivalent, connected to the mains was 65,328, and in March last the number had increased to 307,849.

Another Floating Exhibition.

It is stated by the *Electrical Review* (U.S.A.) that on November 15 a large steamer will sail from Seattle, Washington, carrying an exhibition

which the merchants of the Orient will be urged to visit at the various stopping-places. The ship will anchor only at ports of commercial importance. No admission will be charged, but every effort will be made to get as many as possible to come aboard, with preference for those who have business interests. The exhibit will call at Yokohama, Kobe, Nagasaki, Shanghai, Hong Kong, Manila, Singapore, Colombo, Mauritius, Delagoa Bay, Cape Town, Adelaide, Melbourne, Sydney, Honolulu, and, on the return voyage at Santiago, Valparaiso, and Callao, South America. A stay of from two to ten days will be made at each of these ports, a total of about six months having been assigned for the voyage.

Perth Tramway System.

At a recent meeting of the Tramway Committee the report by the engineers, Messrs. Kincaid, Manville, Waller, and Dawson, on tenders for the reconstruction of the tramways was submitted for consideration. Mr. Dawson was questioned as to various points—especially on the proposal to introduce petrol cars. In reply to Mr. Lawrie, Mr. Dawson condemned the introduction of the petrol car, contending that a ten minutes' service could only be obtained by electricity. He pointed out that in any case the town council would have to relay the rails, and this being so, the introduction of the petrol cars would involve considerable expenditure, whereas if they decided on electricity, the relaying of the rails would be about half of the total cost. We understand that the committee will hold another meeting with the object of deciding what recommendations should be made to the town council.

British and American Trade with Nagasaki.

During the year 1903 imports from the United Kingdom included £3,589 for electric machinery and motors; £1,699 for fire-engines and pumps; £1,218 for lashes; and £3,964 for machine tools of various descriptions. The largest items among imports from the United States were £8,129 for electric motors; £7,334 for lifting machinery; and £3,980 for lathes and other machine tools; whilst the only item of importance amongst electrical imports from Germany was £2,939 for electric motors. A brick building, 85 ft. long by 34 ft. wide, has been added to the electric power-house at the Akunoura Engine Works, one part of the building being used as the hydraulic power-house, and the other part for the electric power-house, equipped with one powerful battery plant consisting of a 100 k w. motor-driven booster and 132 Tudor cells with a discharge capacity of 3,000 ampere-hours.

Electric Headlights on Locomotives.

Some of the new locomotives on the North Western Railway of India have recently been fitted with powerful electric headlights of American manufacture. The equipment consists of a turbo-generator mounted on the boiler behind the dome, and two projectors mounted on the head of the engine and the rear of the tender respectively. The projectors are capable of movement over a wide arc both horizontally and vertically by a quadrant and a screw elevating gear, both of which are operated from the cab of the engine. The reflectors are shaped so as to throw a parallel beam of light which, under favourable circumstances, will illuminate a straight track to a distance of three-quarters of a mile. The lamp is of a peculiar pattern, the negative electrode being of copper, while the upper is a solid carbon. The turbo-generator consists of a small turbine coupled through a flexible coupling to a four-pole generator furnishing direct current at a normal pressure of thirty-five volts. The connections to the generator and lamps are run in wrought iron tubes.

The Toronto and Niagara Power Company.

The construction of the plant of the Toronto and Ontario Power Company, formed to provide transmission lines from Niagara Falls to Toronto, is making good progress. The right of way has been purchased for the entire system, and will be eighty feet wide, sufficient to accommodate the rails of the proposed Toronto and Hamilton Electric Railway Company, as well as the power cables. Two transformer stations are being erected in Toronto, and cable towers have been erected as far as Davenport. From Davenport the line will run through Toronto Junction to Lambton Mills. From this point it will be parallel to the Canadian Pacific Railway to Islington, and then take a direct line west of Clarkson. Thence its course will be parallel with the Grand Trunk Railway to a point north of Bronte, and from there will follow a direct line to Burlington. From Hamilton the line will proceed to a point near Stony Creek, up the mountain to the top of the escarpment just beyond Grimsby, and in a direct line to Niagara Falls. A branch line will be constructed from Islington to New Toronto, a distance of about three and a half miles.

Messrs. Dick Kerr and Co., Ltd.

In the report for the year ending June 30 last, submitted to the general meeting of the company on the 27th ult., it was stated that the profits amounted to only £84,170 as compared with £110,449 for the preceding year. Debenture and loan interest, trustee's fees, and provision for the premium payable on the redemption of the present debenture stock absorbed £14,441 leaving £69,729, to which must be added the profits brought forward, £35,544, making a total of £105,274 availale for appropriation. After paying the dividend on preference share capital, a dividend of 10 per cent. on the ordinary shares, and providing for reserve as required by the Trust Deed, a balance of £39,922 was carried forward. During the past year the company has successfully completed the electrification of the Lancashire and Yorkshire Railway between Liverpool and Southport, and the Hong Kong and Mandalay electric tramway systems, and are now carrying out large contracts at Tokio, Singapore, Bangkok, and elsewhere. The directors intend to study in every manner possible the means of reducing the cost of manufacture, and have every reasonable hope of submitting favourable accounts in the future.

ELECTRIC FINANCE and Legislation

Telephones.

By the ASSOCIATE EDITOR.

Now that our hard worked Members of Parliament are taking a rest, it is to be hoped they will have occasion to ponder over and weigh carefully the suggestion made by the Postmaster-General that the Government should buy out the National Telephone Company. Although the suggestion sounds simple, there are many difficulties and we are inclined to think that a careful consideration of these difficulties will show that the Government would be well advised to leave the nationalisation of the local telephone service alone.

There is a just and reasonable demand for a cheaper service than that now rendered by the National Telephone Company, and we think the municipal experiment at Glasgow has clearly demonstrated the fact that an efficient service should be obtained in provincial towns for a very much lower charge than that now in force, but we must consider the conditions under which the Company is now working and the fact that it has had during its comparatively short life to bear the burden of developing and perfecting the telephone system; but the special condition which is causing the present high charge and retarding development is that the licence under which the Company are allowed by Government to work, expires in 1911; consequently the Company must have great difficulty in connection with its capital expenditure, as it can only undertake those extensions which will show an immediate and substantial return. If however the term of the licence was extended considerably, it might be possible for the Government to make such a bargain with the Company that the telephone user would benefit materially without imposing further burdens upon the country. If the telephones are purchased by the Government the purchase consideration must be provided either by a direct charge to the taxpayer or by means of a loan repayable over a term of years. The interest upon this loan and sinking-fund charges will fall upon the general body of taxpayers, unless the profits are sufficient to meet the charge, just in the same manner as they are now doing owing to the loss upon the London telephone system of the Post Office.

There are, we think, several reasons why a loss will for some years occur in connection with a national system of telephones. The telephone user will undoubtedly expect a reduction in the charge or he will fail to see the advantages of nationalisation. The whole system will need greatly extending, and in many places bringing up to-date, as the present system is in many places only a single wire overhead one. This will require considerable capital, much of which will not be immediately productive, and it is very doubtful if the Government will be able to work the system as economically as the Company has been able to do, if we may judge from the telegraph records, where we find the percentage of salaries to total revenue has increased from 39.13 in 1870–1871 to 68.58 in the current year.

It cannot we think, be assumed that if the Government purchase now, there will be any considerable reduction of capital, consequently the telephone user or taxpayers will have to meet heavier financial charges than the Company is now doing, because in addition to the charge for interest there will be charges to provide for the repayment of loans. Then there is the nature of the business to be considered, improvements both in principle and details are so rapidly being made, that immense allowances must be made to cover depreciation or antiquation, and although the Company are placing to reserve large sums yearly, it is very doubtful if the capital of the Company is now represented by actual assets of equal value, putting on one side the value of the goodwill. It is also a question for consideration whether the Government should risk the interests of the whole country for the sake of benefiting the few who are telephone users and who, generally speaking, are quite

able to pay even the present charges. If the life of the Telephone Company is extended, no one will suffer, because the Postmaster-General can always allow municipalities to compete, and the fact of this possible competition will no doubt induce the Company to deal as gently as possible with their subscribers.

DUBLIN ELECTRIC LIGHTING.

FOR many years the Dublin Corporation have been in a state of uncertainty with regard to electrical matters with the result that very little progress was made, but under the guidance of Mr. Robert Hammond, a new generating station was built, and the system of supply altered to conform to modern ideas. The capital expended approaches half a million, and the result at the end of the last financial year is what would naturally be expected, a considerable deficit necessitating a rate in aid. This has apparently stirred the Council, or, at any rate, a considerable section who are once more in a state of uncertainty. An application to the Local Government Board for powers to borrow £21,000 for the purpose of extending the generating plant, was not approved because the Dublin Council had not passed the formal resolution asking for the loan, consequently the opposition, upon the matter being brought before the Council, have had an excellent opportunity and have referred the matter back. Mr. Hammond has now put two proposals before the Committee, the first is that he should receive as remuneration for seven years the difference between his estimated works cost of three halfpence per unit, and the actual lower cost at which the electric current can be produced. His second proposal is that as the interest and sinking-fund charges will exceed the profits, he undertakes to relieve the Council of all these capital charges for a period of not less than fourteen years if they will hand over the undertaking to him to be worked, and he is prepared to guarantee that the price charged to the consumers shall not be increased. No doubt Mr. Hammond is trying to show the Dublin Council the faith he has in the undertaking, but we anticipate that the opposition will not be satisfied with the idea that it will take fourteen years before the profits equal the losses. We notice in the discussions and local comments, the important question of depreciation has been ignored, but it is of the utmost importance because the undertaking, owing to the very fact of reconstruction, must have capital which is now unrepresented by assets, and which should be repaid, otherwise the undertaking will be burdened by the interest and sinking-fund charges for years to come.

LEGAL AND FINANCIAL NOTES.

Southwark.

THE Borough Council of Southwark have lately had to consider the appointment of a new head to their electrical department. The suggestion that they should advertise for an electrical engineer to manage the concern was opposed. Councillor Cluer said they did not want an electrical engineer to manage the concern, but a commercial man who would go out and canvass for customers, while a mechanical man should manage the station. Alderman Boyd said they did not want an electrical engineer with a lot of letters after his name. Properly speaking there was no such thing as an electrical engineer. Any person of ordinary intelligence could read up in a month all that an electrical engineer knew. There was nothing in it. It was all a lot of theory.

Can it be wondered at if Corporations get their undertakings into difficulties, indeed it is certain that if such large and involved matters as the supply of electricity, tramways, &c., are to be controlled with safety to the ratepayer, some more efficient method of selecting representatives will have to be evolved.

Huddersfield Tramways.

THE annual accounts to March 31, 1904, for the Huddersfield Corporation Tramways should be carefully considered by all those thinking of undertaking Municipal Trading enterprises. In past years the allowances for depreciation have been altogether inadequate, and the Department is now in consequence making heavy calls upon the rates, the deficiency last year necessitated a rate in aid of sevenpence in the pound, while the returns under review require a rate in aid of fivepence in the pound.

The following figures give the financial result:

Capital expended	£411,722
Traffic revenue	£63,700
Revenue from other sources	£2,183
Total revenue	£65,883
Operating costs	£34,665
Percentage of Operating costs to total revenue	53
Gross profit	£31,218
Percentage of gross profit to average capital	7.68
Interest on loans and lease rentals, less interest receivable	£13,632
Sinking-fund	£10,638
Percentage of ditto to average capital	2.62
Financial result:	
Depreciation	£11,687
Deficit	£4,739

Tyneside Tramways and Tramroads Co.

AT the recent half-yearly meeting of the Tyneside Tramways and Tramroads Company, Lord Armstrong foreshadowed the early issue of debentures—an issue already delayed by the discussion over running powers with the Newcastle Corporation. The amount offered is £40,000, forming part of a total issue of £65,000 in debentures, which constitute a first charge on the undertaking of the company. Of the total there remains a balance of £25,000 unissued, and that will be issued only in proportion to the issue of further shares. The debentures now on offer will be redeemable at the end of fifteen years, or earlier on six months' notice, at par after June 1914, and at 2½ per cent.

premium between that time and June 1909. The amount of capital already issued by the company is £120,400 divided into 12,040 shares of £10 each, all of which is paid up. The present issue of mortgages of £40,000 is part of the total issue of £65,000 authorised by the company's Acts of Parliament to be borrowed, and is being raised in connection with the extension of its lines.

Railway Returns.

THE Board of Trade Railway Returns for the year 1903 are well worth studying, although the volume of figures contained in the report will be more than most people will care to investigate.

The investor will no doubt ponder over the fact that the proportion of net earnings to capital have declined from 4.56 per cent. for the quinquennial period 1871–75 to 3.40 per cent. in 1903. The decline is a steady and gradual one and cannot be attributed altogether to tramway competition, but a comparison between the 888,604,000 third-class railway passengers and 759,466,000 tramway passengers carried in 1896, with the 1,086,205,000 railway passengers and the 1,681,949,000 tramway passengers carried in 1903, shows the enormous strides tramways are making, and that comparatively the railways are standing still.

Another set of figures should interest local authorities. The total amount of rates and taxes paid in 1894 was £2,816,000, in 1903 it was £4,493,000. It would be interesting to go further into these figures, and ascertain to what extent the increase in rates has affected the Railway Companies' profits.

Walthamstow.

THE returns for the second year's working of the Electrical undertaking of the Walthamstow District Council are most interesting, the generators are driven by gas-engines using producer gas, and it is therefore most instructive to compare the result with other works using steam-as the motive power; and as Stepney is a good example of a steam-driven station the figures for the third year's working at Stepney have been compared with the second year's working at Walthamstow.

	Walthamstow.	Stepney.
Capital expended	£112,475	£153,291
Total revenue	£12,960	£18,518
Total cost	£4,451	£9,018
Gross profit	£8,509	£9,500
Percentage of gross profit	9.05	7.08
Lamps connected 8 c.p.	42,000	58,314
Units sold	814,187	1,759,349
Average prices obtained	3.51*d.*	2.46*d.*

From the figures given above it will be seen how well the Walthamstow results, although upon a much smaller scale, compared with the Stepney results; and we shall look forward with interest to the financial return of some of the other undertakings where gas-engines have been adopted.

Buenos Ayres Electric Tramways Company (1901).

THE report for 1903 states that gross receipts for the year from the sections opened for traffic amounted to £18,282, and the working expenses, inclusive of London administrative charges, to £15,913, showing a net profit of £2,506. Part of the amount required for the debenture interest to date had been provided by the vendor syndicate. At the commencement of the year the line was working up to Maldonado (5.6 miles) and a further section from Gazcon to Triunvirato (1.5 mile) was opened in June last. On October 22, 1903, the Chacarita section (three miles) was also opened, giving an immediate and encouraging increase in receipts. The construction of the remaining sections—namely, the Belgrano and Flores sections—was proceeded with, but as these were not completed during the year, no benefit accrued to the company therefrom. The business of the company was greatly hampered by the construction and heavy repairing work which was proceeded with throughout the whole year, not only on the new lines, but also on the old lines taken over, often necessitating the running of the tramway on a single track, and the results of the year cannot therefore be considered as giving any indication of the company's real earning capacity.

Company v. Municipal Control.

IT is curious and instructive to watch the application of laws passed for the protection of the public when such laws require the prosecution of a company or municipality. Our attention is directed to this matter by two cases which have lately arisen. At Norwich a tram conductor in the employ of the Norwich Electric Tramways Company was fined for allowing an excessive number of passengers, and also for allowing certain persons, not being officers or servants of the company, to ride on the car platform, and at Middlesbrough a car driver in the employ of the Imperial Tramways Company was fined for driving a tramcar at a speed exceeding eight miles an hour. In most provincial towns where the local authority own the tramways, cars are constantly overcrowded and run at a speed exceeding that allowed by law, the unfortunate passengers suffer the risk and inconvenience, because the local authority whose duty it is to protect them, have, by entering into trading ventures, placed themselves in the unfortunate position of not being able to serve two masters. We find no fault with these prosecutions, but undoubtedly the same laws should be applied with equal strictness to both company and municipal undertakings.

Wood Green.

WE are pleased to see that the Local Government Board are exercising more care in connection with the application of local authorities for power to borrow money for electric lighting purposes. At Wood Green an inquiry has lately been held to consider an application from the District Council for a loan of £43,570. There was considerable opposition to the application from the North Metropolitan Electric Power Distribution Company, who wished to obtain a contract to supply electricity in bulk to the Council at 2½*d.* per unit, the engineers for the Council maintaining that it would be quite as cheap even during the first seven years to generate electricity locally. The following letter from the Local Government Board is of interest. It reads as follows: "I am

directed by the Local Government Board to state that they have had under consideration the report made by their inspector, Mr. Hooper, after the inquiry held by him with reference to the application of the Urban District Council of Wood Green for sanction to borrow £43,200 since increased to £43,570. The Board have very carefully considered all information placed before them by the District Council, and it appears to them upon that information to be extremely doubtful whether the scheme, if carried out, would be likely to prove a financial success. The evidence given as to the probable demand for current was of an unsatisfactory character, for it was first stated that the demand was estimated to be equivalent to 330 consumers at sixty 8-c.p. lamps per house, but when it was pointed out and admitted by the engineer that the number of lamps estimated for was far too high considering the class of property to be supplied, the estimate of the demand was altered to 660 consumers at thirty 8-c.p. lamps per house. It does not clearly appear in what manner either estimate has been arrived at. The Board consider that the district Council, before undertaking a scheme of the magnitude proposed, should obtain more reliable information as to the extent to which the electric light is likely to be taken up."

Willans and Robinson, Ltd.

THE half-yearly report of this Company will be read with interest and should be instructive to the investors who are expecting large dividends, and who are generally quite satisfied as long as they receive them, and rarely trouble themselves about the provisions which are being made for reserve and depreciation, both vital points, which in the present case do not appear to have had sufficient attention. The Company have for many years been manufacturing their well-known high-speed steam-engine, and have paid a regular dividend of 10 per cent. upon the ordinary shares. In the latter half of 1902 the dividend fell to 7 per cent., for the next half it dropped to 6 per cent., and for the second half of 1903 no dividend was paid on either the preference or the ordinary shares, but there was a debit balance of £7,932. The report is as follows:

"In submitting the accounts for the half-year ended June 30, the directors of Willans and Robinson, Limited, deeply regret that the results are so unfavourable. Apart from losses at Queen's Ferry, which, under the circumstances were inevitable, the company's operations resulted in a loss. After making a somewhat increased allowance for depreciation, amounting to £7,601, there is a loss of £3,345 in respect of Rugby. The loss at Queen's Ferry, after writing off £9,937 depreciation, is £25,902, and there is further, a debit balance of £7,932 brought forward from the preceding half year. The loss at Rugby is attributable chiefly to the extreme badness of trade, under the stress of which orders are taken by many firms at prices which make profit impossible. As they have before explained, the directors have striven to open up new branches of business, with a growing success upon which they found strong hopes for the future; but such work cannot yield a profit at first, and, in fact, in its initial stages, it is bound to be a source of loss. This affects not only the half-year under consideration, but also the current half-year, and probably the next half year as well. Nevertheless, the directors are satisfied that in developing these new branches of work, of which steam turbines and gas-engines are the chief, they are taking the surest course for the ultimate revival of the company's prosperity. They are also endeavouring to economise in every way, and have effected large reductions in expenses, though the evidence of this will not be apparent until the accounts of the current half-year are presented. The utmost is being done to maintain the reputation of the company for excellence of manufacture, and to keep the Willans engine in its old position of supremacy. In their efforts to this end the Board feels that it is greatly strengthened by the additions made to it last spring. It is not possible to operate the Queen's Ferry works upon a sufficiently large scale to make a profit, or even to pay expenses, without raising more capital for plant and for working. This is out of the question at present, and therefore the works are kept employed only to the extent necessary to complete one important contract. While the works are thus maintained as a going concern (except the steel works, now closed, but capable of being readily restarted), the directors are endeavouring to find a purchaser for them—subject, of course, to the assent of the trustees for the debenture stockholders. Negotiations to this end are in active progress. The increased loss at Queen's Ferry is largely due to the increase in depreciation (£2,688 more than last year). An unexpected source of loss has also arisen in the necessity for rejecting, and valuing only as "scrap," a quantity of material made in the earlier stages of the work, and believed at the time to be satisfactory. This source of loss is not likely to recur; but, under present conditions at Queen's Ferry, some loss cannot be avoided, even if the works be closed entirely. Everything that is possible is being done to reduce expenses and to increase efficiency. The directors have given constant attention to the improvement of the financial position of the company, which is the dominant factor in the situation. New business and even the best founded hopes of future profits, will be fruitless unless the company can pay its way and has working capital at command. The directors are glad to say that the financial position during the past few months has much improved. Money has come in comparatively freely from debtors, and shares in other companies (received in part payment under contracts) have been sold at favourable prices. The debt to the bank has been paid off, and an ample balance created, without selling the whole of the reserve-fund investments; investments remain at this date which, at cost, represent £27,053. The loss upon realising the securities sold, at the present low prices, has been charged against the reserve-fund account, which has also been debited with an amount written off from other investments of the company, which the directors have rigorously valued down to what they believe to be thoroughly safe figures."

New ELECTRICAL PATENTS

Selected Specifications.

By E. de PASS, F.Ch. Inst. P.A.,
78 Fleet Street, E.C.

"Electric Arc Lamps."

(No. 6305. Dated March 15, 1904. Heinrich Beck, of Meiningen, Germany.)

The present invention relates to an electric arc lamp of the kind described and characterised in the Patent Specification 16294-03, in which the feed of the electrodes which are arranged at an angle to each other or parallel to one another, is regulated by the consumption of the electrodes themselves supported in a suitable manner.

In the arrangements described in the above-mentioned patent specification, the electrodes were provided with lateral supporting ridges of carbon, which rested at their extreme points on a rest or support and were consumed gradually under the action of the arc.

It has been found from experiments that when using an air protecting casing or sleeve of a material which is a good conductor of heat and which affords a sufficient heat radiating surface or volume, the lateral combustion ridge of the arc light electrode needs only to be very narrow, and that it can even be discarded entirely when the conditions are very favourable, without the continued formation of a lateral supporting ridge for the electrode and the uniform consumption of the said supporting ridge being interfered with. By means of an air protecting casing or sleeve of sufficient mass or body and of sufficient radiating surface the control also of the feed of circular electrodes for arc light by means of lateral supporting ridges is now rendered possible.

Claims.—(1) A regulating device for electric arc lamps with carbon pencils arranged at an angle or parallel to one another, characterised by one or both of the electrodes resting, with the extreme point or points, which is or are turned away from the crater, upon a support which is adapted to conduct the heat, derived from the electrode, from the supporting point of the electrode to the surrounding air.

(2) In an electric arc lamp with carbon pencils arranged obliquely or parallel to one another, of which the one or both are supported laterally at the extreme point situated below the crater of the arc upon a support, the arrangement of a sleeve, or the like, on the outer side of the electrode above the supporting point, the said sleeve having such a mass and surface that the heat received from the electrode is conducted to a large extent to the surrounding air.

(3) In an electric arc lamp with electrodes arranged obliquely or parallel to one another, of which the one or both rest at the extreme lateral point or points on a support below the crater of the arc.

"Apparatus for Maintaining Two Electric Motors in Synchronism."

(No. 21305. Dated October 3, 1903. Siemens Brothers and Co., Limited, of London. Communicated from Siemens and Halske Aktien-Gesellschaft, Berlin.)

This invention has for its object to maintain two electric motors in synchronism, this being of great importance, for example, in the case of arrangements serving to transmit motion to a distance or in working telegraphic apparatus.

The means hitherto employed for maintaining synchronism in such motors are often only capable of equalising considerable variations or those of some duration and not those of short duration.

According to the present invention the maintenance of two motors in synchronism is effected by causing regulating current impulses given by the one motor to vary the condition of power determining the speed of the other motor on the synchronism being disturbed, the said current impulses being made to bring into action two forces that influence the speed of the motor, of which the one serving for equalising dis-

turbances of short duration only operates until synchronism has been re-established, while the other serving for equalising more enduring disturbances gradually increases to the required amount and continues after synchronism has been re-established.

Claims.—(1) Method of maintaining synchronism between two motors by causing regulating current impulses given by the one motor to vary the conditions of the power determining the speed of the second motor on its synchronism being disturbed, the said current impulses being made to bring into action two forces that influence the speed of the motor of which the one serving for equalising disturbances of short duration only operates until synchronism has been re-established while the other serving for equalising more enduring disturbances gradually increases to the required amount and continues after synchronism has been re-established.

(2) In the method of operating referred to in the first claim producing the variations of force for equalising the said disturbances of short duration by causing the regulating current impulses to effect a rapid alternation of equal increments and reductions of the force during the synchronism of the two motors while with a disturbance of synchronism the increment or reduction occurring for the time being is made to continue until synchronism is re-established.

(3) For carrying out the method of operating referred to in the first and second claims the combination of a motor with a generator driven thereby, two relays, a resistance, and contact arms of a rotary brush, so arranged that during the continuance of synchronism of the motors the resistance is alternately included in and excluded from the generator circuit in rapid succession, while on the synchronism being disturbed the inclusion or exclusion of the resistance is maintained until synchronism is re-established, substantially as described.

(4) In combination with the regulating apparatus referred to in the third claim, an auxiliary motor operating in conjunction with a regulatable resistance such as a crank rheostat included in the shunt circuit of the working motor, for varying the power of the latter on the occurrence of greater disturbances of synchronism.

"Flame Arc Lamps."

(No. 17871. Dated August 18, 1903. Charles Oliver, of Woolwich.)

In arc lamps which burn with long luminous arcs, known as "flame" arcs and in which the carbons are arranged parallel or inclined towards each other instead of vertically above one another as is usual, the arcs burning at the ends of the carbons under a reflector and under magnetic influence or not, the mechanism hitherto in use for feeding them forward together to keep the arc in a fixed position under the reflector has been complicated and unreliable, and has usually resulted in a very unsteady light being produced and in consequence arc lamps of the class named have been unsuccessful.

This invention is designed (*inter alia*) to overcome the above defects, the mechanism being exceedingly efficient, simple, and cheap to manufacture. The invention relates only to arc lamps having electrodes arranged parallel or inclined to each other and in which the length of the arc is maintained at a uniform or sufficiently uniform length or voltage.

Claims.—(1) In an electric arc lamp wherein the electrodes are arranged with their burning points directed downwards and the length of arc is a constant one or practically constant; the herein described method of maintaining the burning point of the electrodes in or about the same horizontal plans throughout the burning of the lamp which consists in normally preventing the descent of the electrodes by the employment of a material which is sufficiently rigid under ordinary temperatures to maintain the electrodes with their burning points in the desired plane, the said material being furthermore of such a character that the rigidity thereof will not be maintained under the heat from the electric arc when the arc approaches said material which latter thereupon permits the electrodes to descend and causes the arc to recede.

(2) In an electric arc lamp wherein the electrodes are arranged with their burning points directed downwards and the length of the arc is a constant one or practically constant or a practically uniform voltage is maintained across the arc; the herein described method of maintaining the burning points of the electrodes in or about the same horizontal plane throughout the burning of the lamp which consists in normally preventing the descent of the electrodes by the employment of a glass rod which is sufficiently rigid under ordinary temperatures to maintain the electrodes with their burning points in the desired plane the said glass rod being furthermore of such a character that the rigidity thereof will not be maintained under the heat from the electric arc when the arc approaches the lower end of said glass rod which thereupon permits the electrodes to descend and causes the arc to recede.

(3) In an electric arc lamp having electrodes arranged and operated as described the combination therein of a fusible rod holders for the electrodes, means to normally

bear against the electrodes and convery the current to the electrodes near their burning points all arranged and acting in conjunction to regulate the feed of the electrodes and means to strike the arc.

(4) In an electric arc lamp wherein the electrodes are arranged with their burning points directed downwards; the combination with such electrodes of a rigid rod of glass or fusible material, means to afford escape of that part of the fusible material which has been sufficiently acted on by the heat from the arc, means which will prevent downward movement of said fusible rod while the latter is in the rigid state, means to cause descent of the electrodes, a connection between the rigid material and the means to cause descent of the electrodes so that such descent is governed by said rigid fusible material, guides for the electrodes, means to normally prevent the electrodes dropping out of their guides, and a guide to support the fusible material throughout its length in order to prevent buckling or breakage thereof.

(5) In electric arc lamps constructed as claimed above, the use therein and combination therewith of a stop comprising a metal tube sleeve or socket having means at the top thereof for attaching same to the lamp and provided at its lower end with a bent tongue or extension which interposes in the path of travel of the fusible rod through the tubular part of said stop.

"Electric Arc Lamps."

(No. 16294. Dated July 23, 1903. Heinrich Beck of Meiningen, Germany.)

This invention relates to electric arc lamps for use on either continuous or alternating circuits. The objects of the invention is to provide an automatic arc lamp of simple construction in which the complicated electrically controlled feeding devices as hitherto used are dispensed with. The invention consists in regulating the feed of the electrodes by means of the gradual burning away of the same by the heat of the arc, this regulation being effected by resting a suitable part of one or both carbons on a fixed or movable support in such a way that as the carbon burns away it is allowed to descend gradually so as to maintain the arc. The invention also consists in various forms of and details of electric arc lamps in which the feed of the electrodes is controlled in this way. In one form of the invention a ridge of carbon is provided on one or both of the electrodes of the lamp, in particular upon the positive electrode, which ridge rests upon a suitable support, and is gradually consumed by the heat of the arc in accordance with the burning away of the electrodes proper so as to result in an absolutely uniform descent of the lamp electrodes. In the case of only one electrode with what I will call combustion ridge being used, my invention also provides for a suitable coupling of the two electrodes by means of which the uniform feed of both electrodes is secured. In order to prevent the supporting ridges from burning out laterally in their lower parts, this part of the combustion ridges is surrounded with means for restricting the admission of air, a sleeve or the like for instance, in one modification of my invention. Inasmuch as the combustion ridges are made of carbon, an absolutely uniform combustion or vapourising of the lower part of these supporting ridges where they are facing the arc light, is produced which would not be possible for instance in the case of supporting ridges made of metal. Nor is the arc light disturbed by the dropping off of particles of the material of the supporting ridges. With supporting ridges of carbon of sufficient thickness, a pointed end is formed on the contrary which reaches beyond the arc light electrodes proper, and which acts as a lateral abutment and bordering of the arc light. The variations to which arc lights of more than ordinary length such as the so-called flame arcs of electric arc lights are particularly subject are prevented from taking place by the lateral abutments formed by the said combustion ridges, or they are at least considerably reduced.

Claims.—(1) In electric arc lamps the method of controlling the feeding of the electrodes by providing one or both of them with a longitudinal ridge of carbon or similar material which rests upon a supporting surface and is gradually consumed in the heat of the arc, whereby the electrodes descend under the influence of gravity and maintain the arc of practically constant length.

(2) An electric arc lamp in which one or both of the electrodes are supported by means of longitudinal ridges on the electrodes which ridges rest upon supports and are consumed by the heat of the arc as the electrodes burn away.

(3) In an electric arc lamp as claimed in Claim 2, an electrode having a supporting ridge of such a sectional area as to allow of the formation of a pointed edge of the said ridge extending below the end of the electric arc.

(4) In an electric arc lamp as claimed in Claim 2 in which the electrodes are provided with longitudinal supporting ridges, means for restricting the access of air.

(5) In an electric arc lamp as claimed in Claim 2, an electrode having a supporting ridge provided with a metal coating to retard the burning away of the said ridge.

The leading contents of the periodical electrical press of the world, papers read before Learned Societies, and any other literature treating upon electrical subjects are arranged *under subject-matter* in this section. Suitable references are made to the names and dates of the various papers, and the whole forms an index guide of considerable importance and value.

Power.

Articles.

*Multiple Control of Press Motors in San Francisco. W. H. Allen.	*Elec. Wrld. & Engr.* 27/8/04.
Steam Turbines. L. Drin.	*La Rev. Elec.* 30/8/04.
Hauterive Hydro-electric Plant (Friburg), Switzerland. (Concld.) Dalemont.	*Bull. Montef.* 31/8/04.
*Power House of the Interborough Rapid Transit Company.	*Power, Sept.*/04.
Gas-Producers for Power. J. S. Wile.	*Power, Sept.*/04.
Yorkshire Power Company's Station. W. H. Booth.	*Power, Sept.*/04.
*Gas Operation in German Central Work. A. Gradenwitz.	*Power, Sept.*/04.
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General Review of Railway Work. L. Duncan.
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*Relation of the Technical School to the Business and Profession of Electric Railways.	*Utica Conven.* 15/9/04.
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Measurements of the Energy of Light and Heat Radiation from Electric Light Sources." Dr. W. Wedding.
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*An Engineering Degree and How to Get One.	*Elec. Eng.* 3/9/04.

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*Steam-Turbine Generators.—The Principles of their Design. B. A. Behrend.	*Elec. Rev. N.Y.* 10/9/04.
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*Starting of the Heyland Single-Phase Induction Motor. A. Boyd.	*Electn.* 23/9/04.
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Tuning Experiments on Tesla Transformers. H. Mosler.	*Elek. Zeit.* 29/9/04.

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*The Heating of Three-Phase Cable-Sheaths. M. B. Field.	*Elec. Rev.* 23/9/04.

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The Status of the Electrical Contractor. A. H. Stott.	*Elec. Wrld. & Engr.* 10/9/04.
*Railway Rates and Charges. C. H. Watts.	*Elec. Times,* 15/9/04.
The South African Electrical Industry.	*Elec. Rev.* 30/9/04.

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The Growing Duties and Responsibilities of the Municipal Electrician. W. Brophy.	*Elec. Wrld. & Engr.* 10/9/04.
Electrical Law in the Colonies and India.	*Elec. Rev.* 30/9/04.

Patents.

Articles.

*Compulsory Working of Patented Inventions. A British View. W. Craig Henderson.	*Elec. Wrld. & Engr.* 3/9/04.

Articles marked with an asterisk are of exceptional interest, and well worth reading. Copies of any article or paper can be obtained on application to this office, a nominal fee only being charged for the clerical time occupied in taking out same. If desired, the whole publication will be procured (same not being out of print) on payment of the published price.

Where foreign papers have a similar title to those published in this country, the initial letters of the place of publication will be inserted after the abbreviated name of the particular paper; for instance, the English Electrical Review will be abbreviated Elec. Rev., and the American Electrical Review, Elec. Rev. N.Y.

New Catalogues

POWER.

Dynamos and Motors.—MATHER AND PLATT, LTD., Salford Iron Works, Manchester.—A copy of the third edition of the multipolar dynamo catalogue has reached us, from Mather and Platt, Ltd. It is tastefully produced in a crimson cover and contains several excellent illustrations of the firm's large dynamos. A complete specification and full price-lists make up the catalogue. Standard machines are built from 14 to 1,000 k.w. for voltages between 110 and 550. (See p. 409.)

ROYCE, LTD., Trafford Park, Manchester, have forwarded their dynamo and motor list, being Section I of their complete catalogues. It contains full particulars and prices of the firm's standard motors and dynamos. These are of the multipolar and two pole types. The catalogue is well printed and all the illustrations are exceptionally clear.

H. T. BOOTHROYD HYSLOP and Co., Primrose Works, Bootle, Lancashire, have just issued a handy list of their dynamos and motors, which are manufactured in various sizes. A speciality is made of protected motors which are listed up to 40 h.p., prices also being given. The multipolar generators and other electrical apparatus such as winches, lift gears, and water-tight motors are described in a series of neat leaflets.

Motor Starters.—BRITISH THOMSON HOUSTON CO., LTD., Rugby.—List Nos. 173 and 174, dealing respectively with field and motor starting rheostats, have just reached us. The former gives particulars of field regulators for various sizes and types of generators, from the smallest self-contained regulator to the motor controlled apparatus. The latter list is very complete and gives clearly all details as to the various designs of switch made. The pamphlets are produced in the company's usual superb style, the illustrations being very well printed.

Complete Equipments.—A. E. G., Berlin, Foreign Department.—English manufacturers would do well to copy the style in which some German firms produce and issue catalogues and trade lists. The A. E. G., Berlin, whose London representatives are, as our readers well know, the Electrical Co., Charing Cross Road, have supplied us with their complete lists in an exceptionally neat and compact file. This is at present about half full, and as additional lists are issued they will find a place quite naturally and in classified order among their predecessors. The lists in question contain full particulars of the company's specialities from the largest generators and power equipments to the smallest motors and lamps. Much useful data is spread out among the various sheets, and the pages are notched with reference tabs which make reference a simple matter. It seems almost im-

possible to miss finding what is wanted. The pamphlet on the equipment of rolling mills is pregnant with interesting material and should be in the hands of every steel maker.

CENTRAL STATION PRACTICE.

Switchboard Accessories. — FERRANTI, LTD., Hollinwood, Lancashire, have issued catalogues Nos. 9 and 10 giving particulars of their alternate current time timit reverse current relay and edgewise moving coil instruments. The former comprises a wattmeter movement of Ferranti standard pattern, combined with a time limit reverse current tripping contactor. It is arranged to operate with a reversal of power equal to 10 per cent. of full load, unless otherwise specified, and will work satisfactorily when voltage falls to one tenth of its normal value.

The edgewise instruments are on the D'Arsonval principle, having a small coil moving in a permanent magnet field. Voltmeters to 750 volts and ammeters with external and internal shunts are made.

Superheaters. — TINKERS, LTD., Hyde, Manchester, have forwarded a leaflet on their new superheater. This is built entirely of mild steel boiler plates and mild weldless steel tubes, and is made to operate in the downtake at the back of a Lancashire or similar boiler. It comprises *four* top boxes or headers to which a series of bent tubes as above are connected. Steam enters at the two outside headers and leaves at a central junction which couples the middle headers together.

Testing Instruments. — R. W. PAUL, 68 High Holborn, W.C., sends us particulars of his moving coil galvanometer, sensitive horizontal galvanometer, and direct reading insulation meter and testing set. We shall give fuller details of these in an early issue.

Metallic Packing.—LANCASTER AND TONGE, LTD., Pendleton, Near Manchester.—What at a distance looks like a school-boy's slate proves on closer acquaintance to be a copy of this firm's latest catalogue. This is a most comprehensive production and should be in the office of every power-house superintendent. Steam traps, piston rings, and metallic packings are all carefully described as well as steam dryers and grease separators. We recommend every engineer to procure a copy. Further particulars of the firm's specialities are outlined in our advertisement columns.

Measuring Instruments.—THE EDISON AND SWAN UNITED ELECTRIC LIGHT CO., LTD., Queen Street, E.C.—Catalogue Section IV, dealing with measuring instruments, testing sets, &c., has been forwarded. It treats fully of the chief "Ediswan" instruments, and gives particulars of many other standard makes which the company is prepared to supply.

Wires and Cables.—The above company has also forwarded Section V of its catalogue, dealing with wires and cables.

LIGHTING AND HEATING.

Incandescent Lamps.—THE EDISON AND SWAN UNITED ELECTRIC LIGHTING CO., LTD., Queen Street, E.C.—Catalogue Section I is a complete list of "Royal Ediswan" lamps. It gives a full account of the company's specialities in incandescent lamps from the smallest to the largest together with prices of all sizes. The list has been carefully compiled and is well printed.

Arc Lamps.—G. BRAULIK, Upper Thames Street, E.C., describes his special Arc Lamp coupling and accessories in an attractive leaflet. The device permits the lamp being lowered from almost any height.

Forthcoming Events

Exhibitions.

Universal Exposition, St. Louis, U.S.A.

Now Open. Remains open till *December* 1, 1904.

Exposition Internationale au Grand Palais, Paris.

August to November 1904.

Industrial Exhibition, Cape Town.

November 1904 *to January* 1905.

Tramway and Light Railway Exhibition.

July 3 *to* 14, 1905.

Meetings, etc.

The Institution of Mechanical Engineers. Session 1904-1905.

Meeting, *October* 21, 1904:

Paper for Discussion.

A Scientific Investigation into the Possibilities of Gas Turbines. By R. M. Neilson, A.M.I.Mech.E.:

Ordinary Meetings as follows:

1904.	*November* 18.	Friday.
	December 16.	,,
1905.	*January* 20.	,,
	February 17.	,,
	March 17.	,,

The Forthcoming Event is the Issue of our

St. Louis Souvenir Number (*November*).

Don't miss it!

The Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

Associate Editors: Leading Authorities in every branch of Electrical Activity.

VOL. II. NO. 5. (11th Issue.) LONDON. NOVEMBER 17, 1904.

THE CONGRESS AND AFTER.

WITH few dissentients, the organs of the electrical industry concur in voting the Fifth International Electrical Congress to have been a complete success. The work of organisation so carefully carried out by the Committee calls for special comment and praise for that body of gentlemen. It is no matter for surprise that the wide scope of the Convention should have occasioned disappointment in some quarters as to results, but despite the fact that many papers read might have been replaced by others, that the place of meeting (outside the Exposition grounds) thinned the attendance somewhat, and that no really new subject was introduced, the gathering must from all points be regarded as undoubtedly superior to its predecessors. We have already commented briefly in the Sections on the chief papers presented, and though, as we mentioned above, no new ground was broken in any of them, the value of the various compilations is in no way discounted, and the proceedings when published (early next year), will doubtless remain as a repository of current electrical thought and work until the next Congress assembles. We may here refer to the work of Section H, electro therapeutics, as indicative of a decided progressive movement in medical circles towards a period in which electrical and medical science will find open and adequate expression in practice. The comparative paucity of topical data on this branch of our industry precludes the possibility of our devoting a special section to it, but having regard to the weight of opinion presented in the papers before Section H at the Congress we are contemplating a move which will provide information from time to time on this important subject. In another branch, electro-chemistry, there are signs of healthy and steady progress, and looking as we do, to the electro-chemists and metallurgists to take up the work of electrical science when electro-dynamics shall fail us, we cannot but be encouraged in our future hopes by the admirable "showing" made at the Congress by the American Electro-Chemical Society. Thus briefly then can we sum up the actual proceedings of the gathering of the electrical clans. What permanent benefit can we look for as the outcome of so important an assembly? The papers read and the opinions expressed are, as we have already pointed out, but sign-posts on the road of progress. Where, then, must we turn in our search for immediate good resulting from these deliberations? To the Chamber of Delegates, formed to express its opinion on matters of vital purport to the electrical industry throughout the world. From the proceedings of this select few from the ranks of the world's electrical men, among whom Colonel Crompton, Dr. Glazebrook, and Prof. Perry were Great Britain's representatives, we gather that though taking no direct action itself, its recommendations on two important issues, electro-magnetic units and elec-

trical standards, if put into practice, are likely to have far-reaching effects on electrical affairs generally. Representing, as it did, the interests of electrical engineers in all important countries, the Chamber of Delegates, in pronouncement on these subjects, has struck a note which will, we are convinced, find echo in the countries from which the delegates themselves were drawn. On the matter of electromagnetic units, it was unanimously agreed that an international governmental commission be appointed to deal with the questions of difference now arising, and if possible to bring about a complete unification of international electrical standards. The value of such a resolution, if ultimately carried into effect, would not only be felt among electrical engineers, but the agreement of parties on matters of international industrial importance might also find a reflex in commercial and political quarters with consequent universal advantages.

The decision on the second matter, that of electrical standard nomenclature and ratings for dynamo electric apparatus, is further pregnant with interest, seeing that a recommendation was made that the technical electrical societies of the world should appoint an international commission also, to effect an understanding on the subject which should be recognised all round. The Chamber of Delegates has thus earned for itself the happy distinction of forging the first link in a chain which shall bind firmly together the interests of electrical engineers the world over. Moreover, the objects in view are such as demand a common focus of attention on the part of the various communities of electrical interests in every country, and this fact augurs so well for the results of the delegates' labours. It seems almost that they have hit on those items—and those only—which could ensure a common understanding among those whom they represented.

We previously expressed the hope that Congress would not fail to accomplish some object worthy of its calling, and we have no occasion to be disappointed.

Before the next International Electrical Congress convenes there will doubtless be many, changes effected in the general aspect of electrical affairs. Should another ten years elapse between this last and the next meeting we may reasonably expect that many problems discussed only recently in embryo, will have reached a practical solution in the meantime. Matters of primary importance which have now formed material for the deliberation of the Chamber of Delegates, and which in their essence are of vital consequence to the world's electrical industry, will by the time of the next Convention have given place to more general items. The existing incongruities in our legislation should have disappeared and the progress of electrical science be freed from obstacles which have proved so disastrous in the past. We dare not expect that in ten years our main-line railways will be electrified, but whereas the present Congress have had plenty to say, or how the problem shall be approached, at the next meeting we may look for definite practical proposals, whose adoption shall really clench the argument for electrification. The subsequent realisation of our present ideas will then follow quite naturally.

In drawing a veil over the closing phases of the Fifth International Electrical Congress, we cannot praise too highly its laudable objects, and, with the hope that we may introduce our readers to the sixth meeting, we combine our heartiest good wishes that the greatest measure of success may attend all future deliberations of electrical engineers, wherever they may assemble.

The editorial on opposite page contains suggestions worthy your immediate consideration.

Our Anniversary and Souvenir Issue.

READERS of this journal will have been generally expecting the publication of our American Tour Souvenir issue this month, in accordance with previous announcements. Since publishing our October number, however, we have considered it advisable in the interests of our readers and of the Magazine to postpone the issue of the number in question until January next. Two important reasons have led to this step. Firstly, our Editor-in-Chief has collected so much valuable data and secured so many interesting photographs of the recent Tour that a complete rearrangement of our original plans has become necessary. Secondly, January next marks the anniversary of the successful launching of this journal among technical publications, and Mr. Feilden is very desirous of emphasising the event in a marked manner. We therefore think that in taking advantage of the timely coincidence to combine the special features of the American Souvenir issue with that of our Birthday number, we shall have the approval and support of our numerous readers. We regret inflicting a disappointment this month, but when the January issue appears it will be found that the waiting has been more than justified. There is an old saying that what is worth doing is worth doing well. In this connection, when we made the announcement last month we were totally unprepared for the plans which Mr. Feilden had in view, and obviously, we could not easily get at his mind over three thousand miles away—in fact, it was a matter of some difficulty to communicate with him at all in view of the friendly but strenuous "hustle" that our American friends gave the British party. The additional time now at our disposal will give us opportunity not only to secure further very interesting matter and photographs from the United States and Canada which have been requisitioned by Mr. Feilden, but will enable us to make the issue more widely known in the interests of an increased circulation, and incidentally of our advertisers. We have no desire to unduly blow our own trumpet, but we do not think we shall be exaggerating when we state that the January number of THE ELECTRICAL MAGAZINE will eclipse anything hitherto done in the way of high-class illustrated technical literature. It will contain not only an interesting record of the Tour from start to finish, generally describing the places visited, but will also give technical descriptions of the power-plant and electrical devices inspected, and will deal in a special manner with the International Electrical Congress and the electrical exhibits at St. Louis. A further feature of interest will be the inclusion of short original articles contributed by leading members of the touring party, conveying their impressions and experiences of electrical American progress and development. The number will embrace other features of interest, and will be profusely illustrated from a large number of photographs expressly taken by Mr. Feilden, members of the party, and others. A number of these photographs are of particular value, and cannot possibly appear elsewhere ; special interest will attach to the personal pictures which will be incorporated in the story.

It is our earnest desire that all who wish to obtain a copy of this unique publication should be supplied. When

this issue is seen it will be recognised at once as a compilation of permanent utility, and from inquiries and orders already received there will doubtless be a very exceptional demand for it. To prevent disappointment, we advise all readers who are not annual subscribers to place their order for a copy without delay with their newsagent or bookstall. We further advise all those whose annual subscriptions are running out at the end of this year to send us their renewals at once. Although the number of copies we shall print will necessarily be far larger than our ordinary editions, we wish it to be distinctly known that we cannot guarantee a copy to any one unless it is bespoken beforehand.

The price of the January number will be double that of the ordinary issue to purchasers of single copies, but regular subscribers will have this number included in their annual subscription without extra cost.

A final word to manufacturers. Having regard to the very exceptional nature of the January issue, and the specially forceful way in which it will be pushed, it is difficult to conceive a medium of greater value for the announcements of makers of electrical machinery and appliances. Advertisers will receive unique publicity among consulting engineers, contractors, and buyers of electrical plant the world over. Firms desirous of securing space will therefore be well advised to communicate with us at the earliest possible moment, as in view of the work involved in getting out this special number the pages will be closed for press some time in advance of the date of publication. To one and all we say, don't miss this issue or we are sure you will regret it.

Opening Meetings of the Winter Session.

PRESIDENTS of electrical societies throughout the country are now exploding their official crackers in the shape of an opening address. The parent institution is not the first in the field, though Mr. Alexander Siemens in his remarks seems to have quite recovered any ground lost in getting away with the winter session in London. His hearers were probably not surprised at his introduction of the metric system into the address, though many would feel themselves, as regards his opening references to capital, labour, and works-management, in the position of a certain lady receiving instruction in the heterodox removal of the yoke of an egg. Mr. Siemens' propositions are none the less valuable, and in exciting comment from the lay Press should do much good. Glasgow University engineers were treated by Mr. Chamen with a review of progress and prophetic references to the future, while Mr. Robertson, before the Glasgow Local Section, presented important particulars of the application of electricity to the coal industry, but especially in Lanarkshire. In Dublin the eternal subject of technical instruction was raised by the President, Mr. Mark Ruddle. Mr. Ruddle is Dublin's City Electrical Engineer and evidently has been much worried by anxious parents as to what shall and shall not be done with their dear ones in fitting them to run in electrical harness. If the President's subject for his address is the outcome of some tantalising in the direction mentioned, we must compliment him on his rejoinder, and the heads of technical institutions can do worse than ponder carefully his critical survey of the present aspect of technical education.

Honours and Congratulations.

To the inventor of the incandescent lamp, Sir G. Wilson Swan, F.R.S., and to the Hon. C. A. Parsons, C.B., F.R.S. the inventor (as far as modern engineering is concerned) of the steam turbine, we extend our heartfelt congratulations on the honours conferred upon them by His Majesty on the occasion of his birthday. The debt of the electrical industry to Sir G. W. Swan is a heavy one, in that through his genius and pioneering the incandescent lamp was first produced and made commercially successful. It is a matter for surprise that the honour to which we now take pleasure in referring was not conferred some time since, but his merits have been none the less appreciated by his colleagues, seeing that he is an honorary member of the Institution.

The Hon. C. A. Parsons needs no introduction to our readers, and we are convinced that they all join us in our con-

gratulations to so eminent an engineer, one whose name is indelibly impressed on the scroll of fame.

Twenty years of Traction.

THE publishers of the *Street Railway Journal* must be complimented on their twentieth anniversary number. It is a triumph of the printer's art, and its articles are a valuable collection of information on electric tramway matters hard to find between the covers of any single publication. Reviews of the many aspects of electric traction appear from the pens of the best writers, and no expense seems to have been spared to make the historical matter authentic and readable. The detailed accounts of the New York Subway plant, both power house and rolling-stock, are the most complete we have yet seen, and for these items alone the number is worth preserving. The issue contains some 178 pages of literary matter which, with something like 360 pages of advertisements, make it an imposing if weighty production.

Mr. Yerkes' New Manager.

OUR congratulations to Mr. J. Young, the popular general manager of Glasgow's Tramways, on his appointment to the General Managership of the Metropolitan District Railway. Mr. Young has a substantial reputation in tramway matters at his back and should be none the less zealous in his control of an extensive railway system operating on the most improved electric lines. His association with the affairs of Glasgow has been a lengthy one, he being first appointed to a position in that city, as superintendent of the Corporation Cleansing Department in 1875. A complete reorganisation of this department was successfully carried out under his supervision, and the Corporation had so good an opinion of his administrative ability as to appoint him General Manager of their new tramway system in 1892. After several years' operation with horses the whole of the routes was converted to electric traction on Mr. Young's recommendation, and the work was carried out under his supervision. In 1902 he was elected first President of the Municipal Tramway Managers' Association of Great Britain, an organisation whose scope has been widened since as the Municipal Tramways Association.

Mr. Young will act directly as the General Assistant of Mr. Yerkes, who, as our readers well know, is chairman of the Underground Electric Railways of London, and General Manager of the Metropolitan District Railways Co. In

Comrie Smith] [*Photo, Glasgow.*

MR. JOHN YOUNG.

this new sphere we wish Mr. Young an even fuller measure of success than has attended his efforts at Glasgow, labours which are so well reflected in that system of electric tramways for which the city has become famous.

New York Subway Opened.

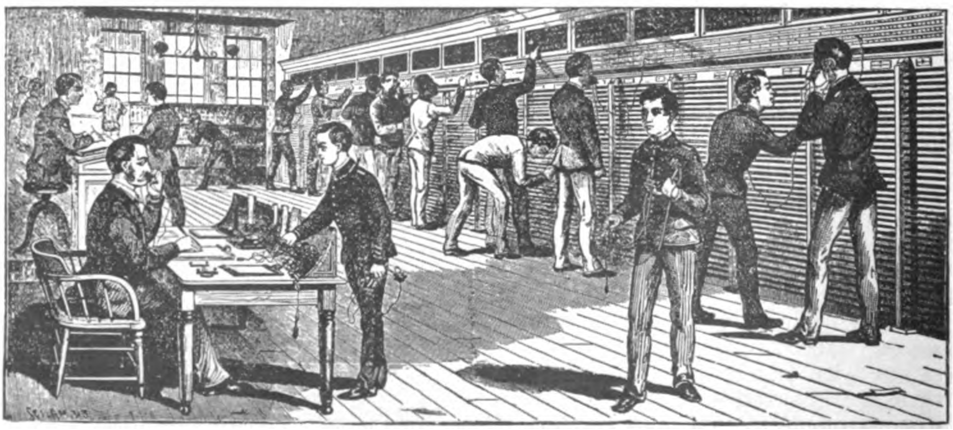
THE opening of the New York Subway on October 27 marks an era in the history of high-speed suburban electric traction, as well as in the provision of rapid transit facilities for a great city.

The Rapid Transit Commission, responsible for the inception and construction of the subway, must be congratulated on its successful issue from a period which could not be otherwise than trying. The performance of a task involving the upheaval of entire streets, the removal and rearrangement of service mains of every description in those streets, and the construction of railway tracks "in storeys" must claim the admiration of every engineer the world over. With its monster power house, sub-station system, electro-pneumatic signalling, fireproof cars, with multiple unit control and frequent service of cars (some 800 a day), the scheme strikes the casual observer with little short of wonder. Needless to say, every precaution against fire and accident has been taken; steel cars and automatic signalling with cut-out switches forming efficient safeguards.

The opening of the electrified underground lines in London will provide us with a system analogous to that just started in New York, but the undertaking has not bristled with difficulties in our case, such as those overcome by transatlantic engineers. Still, as great electric railways affording "intramural" and suburban communication, they will be very similar, and their respective results should yield some valuable comparisons. In our case the lines will be supplied from turbo-driven generators, while "on the other side" the units are of that reciprocating type now familiar to American electric railway practice. Apart from this the systems differ but little, and though in both instances the bulk of the route is under cover, open sections are to be found in which the severe conditions imposed by third-rail service will have to be met in winter. Here, of course, we have the advantages of a milder climate.

Gas Turbines.

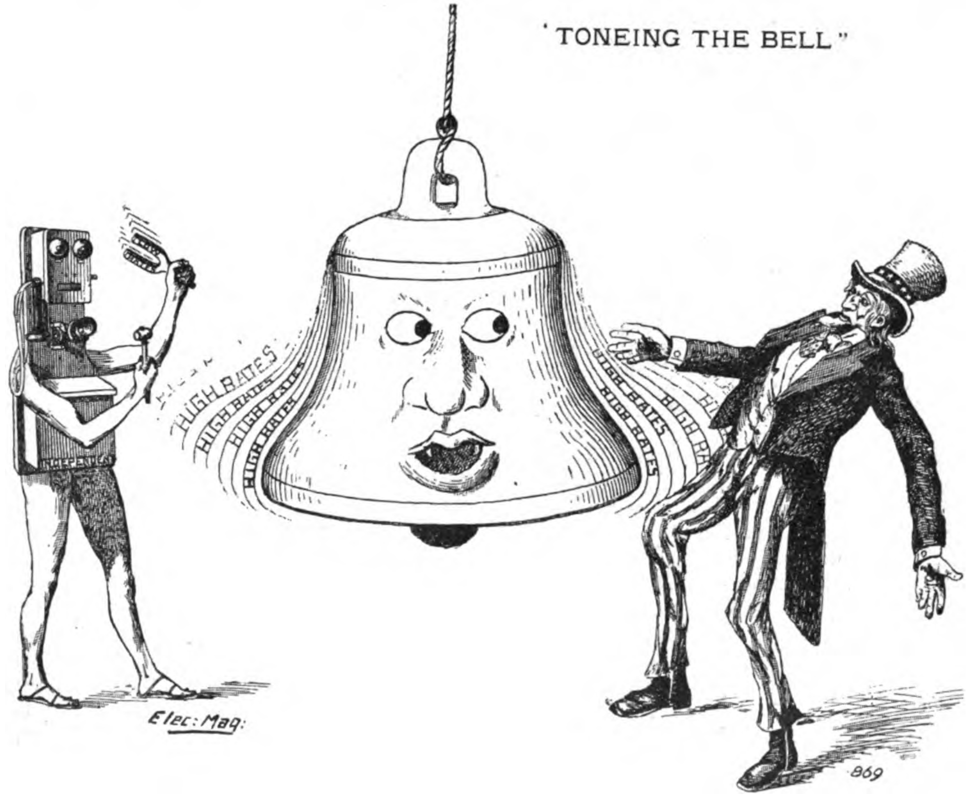
A FAVOURABLE experience with steam turbines has naturally turned attention to the possibility of evolving a practicable gas turbine. The proverbial economies of the internal combustion engine have so far been only produced in mechanisms whose principle has been complicated, compared to the most elaborate forms of the steam-engine. Large engines working on producer and blast-furnace gas have certainly been built and are operating with results difficult of approach by steam-engines, but their design is such as to render dynamo standardisation difficult now that high speeds are becoming common with turbine machinery, while they also are cumbersome and occupy much valuable space. The production of large gas-engines has been a slow process, and it is clear that this branch of industry requires some more powerful stimulus than it now receives from a desire to effect further economies in the present design of plant. The same continuance of popularity which the steam-engine enjoys in its new disguise as a turbine may, perhaps, become the



THE OLD LAW TELEPHONE BOARD, ST. LOUIS
(From *American Telephone Journal*)

(See opposite page)

"TONEING THE BELL"



[From *Electricity*, N.Y.

privilege of the gas-engine if it can don some similar clothing. We have frequently referred to the possible commercial production of a gas turbine, and now we have hopes held out of the realisation of what is certainly an ideal. In our Power Section next month will be found particulars of a German invention for which much is expected as the starting-point in gas-turbine construction. The subject of the gas turbine has also been recently discussed before the Institution of Mechanical Engineers, and although the purely theoretical side of the question was the topic of deliberation the circumstance is sufficiently important to merit notice where the subject is raised in debate. Our gas friends are naturally elated at the prospect of gas turbines. It is hardly to be expected they would remain content with, according to their own statements, beating electric lighting hollow, but are desirous of entering that wider field of power supply which the electro motor has practically claimed for its own. Time will, of course, prove whether gas can be conducted to some power-producing device and converted into mechanical energy with that ease now characterising the electro motor. We should think that the chief field of utility for the gas turbine will be found in the large station of the electric power company, and not, in small sizes, on the premises of the power user. The gas engineer will thus become a party to the supply of cheap power and not a com petitor in it.

Telephone Matters.

IN our last issue we commented editorially on the prospects of automatic telephony generally. We have since been afforded an opportunity of inspecting a series of automatic devices which, from the explanation given and a comparison with other apparatus afforded, bids fair to capture the field if given a fair hearing. From a casual observation, automatic

telephony appears unduly complicated, but when the apparatus for a single line, or pair of subscribers, is scrutinised and the system regarded but as a multiplication of this unit, the complexity disappears. It is true that where a large number of subscribers is handled, selective methods are required at the exchange, but even these, with a simplification of the individual apparatus, become less elaborate; in fact, a general reduction of the complications results. Mr. A. P. Hanson, who so kindly explained his system to us, has devoted many years to a study of the problem, and his solution impressed us very favourably, especially as, in addition to its simpler method, it obviates difficulties which act as drawbacks to other systems. We are not at present in a position to give full details of the apparatus, but when we publish an illustrated account, we are confident of a verdict from our readers in support of our own.

We publish two illustrations, one of an old manual board used in the early days in St. Louis, and which in contrast to our remarks on automatic telephony, is sufficiently striking, and another a cartoon taken from a contemporary, which sums up the telephone position in America. Our readers will be familiar with the rise of the Independent telephone companies in opposition to the monopoly held by the Bell interests. The rivalry thus instigated has continued for many years, and neither party seems much the worse for the competition which each affords the other. From a statement recently made of the output of the Bell companies, we learn that during 1904, 300,000 new subscribers have been added and about 700,000 instruments have been supplied. The average income per subscriber is about $50 per annum.

Birmingham's Electric Club.

The formation of an Electric Club in Birmingham is a matter upon which we must congratulate the promoters. Whether they have copied our Transatlantic friends at Pittsburg we do not directly know, but if their deliberations secure the publicity now enjoyed by those of the parent gathering, they will be open to even greater compliment. The moving spirits, we gather from information at our disposal, are Messrs. M. G. Waggott and W. Dalby, who with five others, including Mr. J. Inniss (since elected President), called a preliminary meeting at which it was decided to report on the formation of the club. From these initial deliberations the matter has grown, and we understand developed into the drawing up of regulations for members, conditions of association, &c., so that to all purposes the club is now a reality.

We cannot do otherwise than wish the venture success, and commend our readers in all parts to emulate so good an example. That there is need for some social atmosphere which electrical workers not directly eligible for election to the Institution or its local section could move, is clear from the feelings inspiring this movement. The growth of the Institution itself is abundant proof of the fraternal disposition of electrical men, and when its regulations exclude certain classes engaged in the same pursuit, but on a different scale, any proposals providing means for that intercourse which is clearly desired by the parties concerned, must receive our hearty support. The expansion of the parent Institution into its now many local sections is an earnest of the success of an undertaking which, as far as we can perceive, will make its influence felt beyond the narrow limits of its birthplace at Birmingham. We shall look for the formation of similar clubs in other large centres, and if a tone of utility in matters electrical is preserved, much good should accrue to those members in particular and the electrical industry in general.

To Test Consumers' Lamps.

In previous issues we have outlined the proposals, made by Mr. Wilmshurst before the last Convention of the Municipal Electrical Association, that central-station engineers should undertake the renewal, inspection, and testing of consumers' lamps. The matter has been freely discussed in the columns of a contemporary, and we have commented upon it in our Lighting and Heating Section from time to time. As a direct outcome of these suggestions, we are glad to see that action is being taken

though not in a quarter originally proposed by Mr. Wilmshurst. The Northern Electrical Testing Co. of 30 Byram Arcade, Huddersfield, has been formed by a group of enterprising electricians, with the object of putting Mr. Wilmshurst's suggestions into practice, and has already issued literature stating its case. From a pamphlet of which we have a copy, we learn that a scale of charges varying from 5*s.* for a 1–25 light installation to 16*s.* 6*d.* for a 150–200 light installation, has been fixed, these rates being for an annual test and report on the state of the installation. Additional sums from 7*s.* to 22*s.* 6*d.* are asked for an efficiency report on the lamps. A company formed for this purpose but operating independently of the supply authorities, might be suspected of collusion with contractors, but we notice from a clause in the circular an emphatic denial of association with outside parties, consequently dismiss any such assumption as devoid of foundation. We hope the scheme will receive the support it deserves, and that users of electric light will not interpret its good intentions as a pretext for extortion. We cannot but feel that remedies of this character are rather prejudicial to the spread of electric lighting, even though their necessity be supported by facts. Though commending the enterprise of the promoters, we look for some drastic improvement in the principle and construction of electric lamps for indoor use, which will relegate these temporary expedients to the limbo of forgotten things.

Regenerative Control.

TRAMWAY engineers are becoming interested in the regenerative control of cars, and under the auspicious guidance of Mr. G. S. Raworth should ultimately adopt it generally. From the present position of events, however, they are still sceptical, and, despite the remarkable economies which they can effect by regenerative motors, are reticent in voting *en bloc* in favour of the system. At the Society of Arts recently (October 20), when Mr. John I. Hall put forward further instructive figures of what regenerative motors could do, there were several questions asked, which from a tramway manager's standpoint are interesting. From these we may select as the most pointed, those relating to the shunt winding, and the slower acceleration with shunt motors. In the first case the shunt coils in bearing the full-line pressure need care in winding, and as the majority of the cars fitted to date with regenerative control have had old motors modified, there has been some difficulty, so we gathered at the meeting referred to, in getting on the desired number of turns with good insulation. In answer to a question raised on this matter, it was stated, that with new motors there would be no trouble, as the motor case would be designed to accommodate a full winding with plenty of insulation. We must remind our readers *en passant*, that in addition to the shunt coils, series coils are fitted for braking should the trolley leave the line. Now, if it is argued that new motors will be needed in addition to the modified control, it seems to us that this additional expense will seriously offset the economies secured by the new system. It would be interesting to know what this extra cost would amount to, as we have not yet seen figures in which the items for conversion are detailed separately. The estimated cost of altering fifty cars is given at £6,000, but £120 per car cannot include new motors. Presumably in installing the system the makers would be asked to rewind old motors, and in that case the shunt winding difficulty would reappear. The second item, that of decreased acceleration, was also to be improved with new motors. We do not, for one moment, hint that the regenerative system of car control is not what it is stated to be. In fact, from a recent inspection of and ride on a car at Gravesend, we were compelled to give the system all praise, and should be pleased to see the system generally adopted, at any rate in hilly districts. The increasing use of electric tramway traction is bringing with it difficulties, and, in many cases, a high rate of plant depreciation. Methods of stimulating business are being suggested on all sides, such as reduced fares, tramway parks, through routes, and goods traffic. All these tend to increase the revenue, but they also require capital, and, on this, they afford some return. With regenerative control, however, the capital expenditure of converting would

appear to be reduced at a rapid rate, and in addition a system thus equipped has materially extended its earning powers, as the same plant and mains will answer for a substantial addition to the rolling-stock.

Tramway Associations.

DURING the past month British and American tramway men have met and discussed their troubles at various conventions. Tramway Associations were originally formed to further light traction interests generally, and in their initial stages were supported and attended by men holding comparatively good positions in tramway spheres. The rival interests of municipal and company tramways could not, on the face of it, be voiced by one body, and in this country two associations sprang up in consequence. Tramway managers, feeling in their turn the need for representation, formed a special association at whose meetings they might be certain of a hearing. We have then in Great Britain three main tramway associations, the Municipal Tramways Association, the Tramways and Light Railways Association, and the Association of Tramway and Light Railway officials. Mr. H. England, President of the latter at its recent annual meeting called attention to the erroneous policy of having three distinct associations, and we cannot but agree that amalgamation, were such a thing possible, would prove generally beneficial, though it is difficult to see how it can be brought about. Company and Municipal interests have each their own champions, and the difficulty seems to be in effecting a reconciliation between them. At present there is little hope of either fraternising on a common platform of tramway interests, and the deadlock now ensuing is likely to continue. In America, where three associations have also maintained a splendid isolation for some time, there is talk of amalgamation, but over there the issues do not involve municipal and company partisans to the same extent. Of the two main associations, the American Street Railway Association and the American Railway Electrical and Mechanical Association, as far as we can gather, the former proved too exclusive for a rapidly rising body of employers who had much to gain in making their wants known in the street railway world. The latter mentioned association was accordingly formed, and has swelled its membership to an extent almost rivalling the parent institution. The third body represented the street railway accountants, but in their case isolation or amalgamation would make little difference, and the issues involved have a more restricted field. At any rate the advantages of one powerful organisation representing the combined interests of the American street railway industry, are fully recognised, and we believe steps are being taken to establish such an institution on a sound basis. Although our case is not exactly parallel to that of America, we might take the hint from this latest move, and, setting aside party jealousies, afford British tramway interests an opportunity of combining in the furtherance of a common cause.

You will be electrified *with our Anniversary and Souvenir number. No need to fear disastrous consequences from such a shock, in fact we anticipate quite the reverse.*

The points of contact *we wish to touch are in the regions of your greatest potential; viz., your keen interest in this issue, your desire for a copy, your willingness to assist in making it successful, and your wish to participate in that success.*

SINGLE-PHASE COMMUTATOR MOTORS. II.

Prof. Dr. F. NIETHAMMER.

(*Continued from page* 356.)

STARTING DEVICES. — If a single-phase commutator motor is directly switched to the line, the highest possible current and the highest possible torque occurs just as for direct-current motors, though on account of self-induction the current rush is smaller. The high-starting current and torque is usually choked—

(1) by reducing the terminal voltage by means of a

(*a*) usual *two-coil transformer.*

(*b*) by a *one-coil auto-transformer* (Fig. 1) or

(*c*) by an *induction regulator.*

(2) By reducing the armature voltage of series motors and compensated motors by means of a *series transformer.* For starting the number of secondary turns must be small, increasing the primary impedance in this way, and choking the line current and increasing the armature current.

(3) By *ohmic* starting *resistances* in the motor circuit or in the armature circuit of repulsion motors. This method ameliorates the power factor at starting from about 20 per cent. to 80 or 90 per cent., but reduces the starting efficiency considerably. Inductive resistances are even more objectionable.

(4) By *brush shifting* of the rotor brushes gradually from the neutral zone where the current is small and the torque nought, to about 70 degrees. This method is excellent for repulsion motors and compensated types. In Fig. 2 is represented in dependence of the brush angle β against the neutral zone : Starting torque Ta, starting current Ia, E.M.F. ea, in the short-circuited coil at starting, Ts = torque at synchronous speed, Is = current at same speed, T cos ϕs = power factor and es = E.M.F. in the short-circuited coil at synchronous speed.

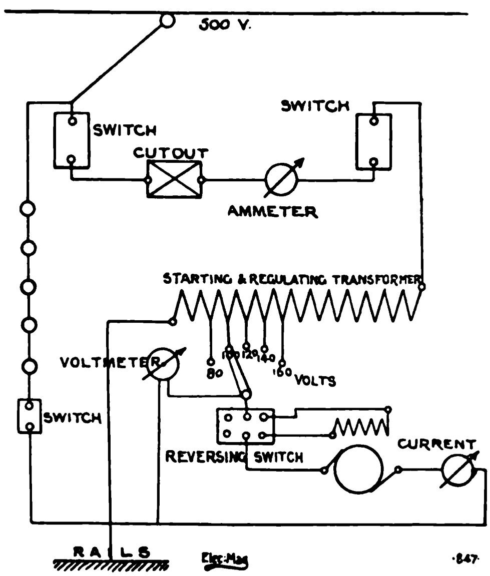


FIG. 1. ONE-COIL AUTO-TRANSFORMER.

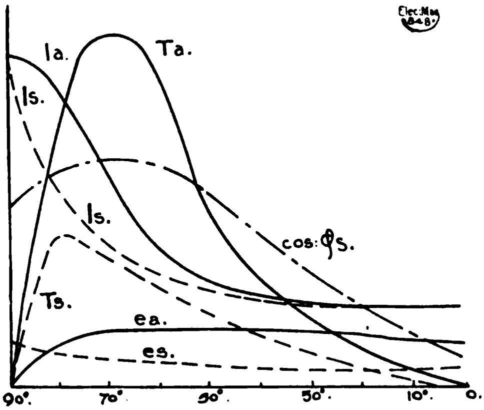


Fig. 2.

(5) By providing equidistant taps on the primary winding which are consecutively connected to the line, having the same effect as brush-shifting; the method may be used in connection with repulsion motors and compensated motors.

(6) *Series-parallel*-control of two or four motor-groups for all types of motors.

The Westinghouse Co. uses auto-transformers and induction regulators on the same car, and adds even balancing coils in multiple with the armatures (Fig. 3). The cheapest transformer is the auto-transformer, the induction regulator the most expensive one, but this one has, however, the great advantage of needing no switching contacts and works therefore sparkless. To overcome the cross ampere turns and the voltage drop caused by them, the induction regulators should be provided with a short-circuited damping coil (Fig. 4). Two-coil or one-coil transformers with taps must be so designed as to allow sparkless switching. The best solution seems to be the use of a dial with a quick-break lever switch, the lever of which jumps to the next contact without ever short-circuiting a coil, but interrupting

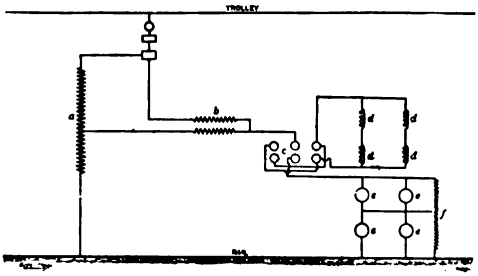
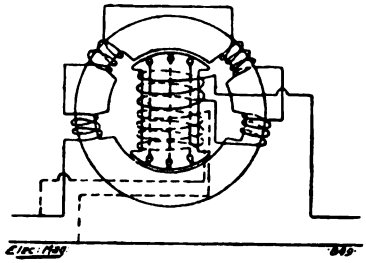


Fig. 3.

Fig. 4.



the circuit for a very short time. No auxiliary choking coils or resistances are necessary in this case. The starting and regulating transformers ought to be oil-cooled or air-blast, and high iron inductions and current densities may be used. For trains single-phase multiple unit control has been developed by the Union Co., the single-phase scheme resembling very much the well-known multiple unit control of the General Electric Co., replacing the direct-current magnets by single-phase laminated magnets which put in circuit more or less low-voltage coils of a series transformer.

All starting transformers when continuously in circuit reduce the efficiency materially.

The direction of rotation is *reversed* by changing the connections either to the armature or field terminals. It is advisable to put the reversing switch in a low-voltage circuit, for instance, in the secondary circuit of a series transformer connected to the rotor. The repulsion motor cannot be reversed in this way, but

(1) By shifting the brushes by about 50 per cent. of the pole-pitch; (2) By

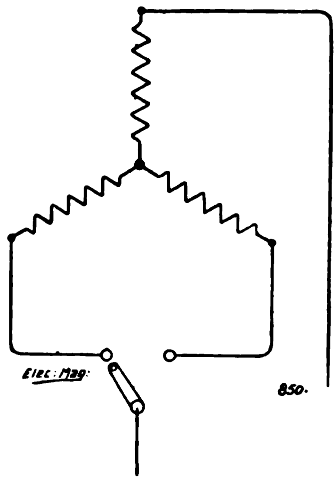


Fig. 5.

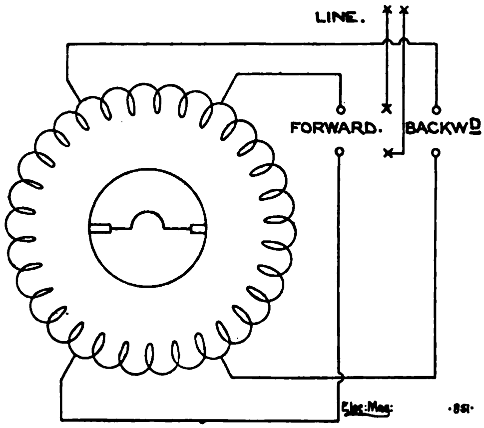


FIG. 5A.

shifting the connections to the primary winding by half a pole-pitch; (3) By using two primary windings shifted against each other (Figs. 5 and 5A).

Speed variation.—All practical commutator motors have the speed characteristic of the direct-current series motor, the curve however being steeper, as the iron inductions are usually lower. As for a given torque, speed is proportional to the armature voltage, the speed may be varied in the widest range by applying a transformer with variable ratio across the motor terminals or across the armature terminals. This method is very efficient, as no losses in resistances occur. Speed may be also changed by ohmic and inductive resistances in series or in multiple with the various motor windings, by series parallel control of various motors, by brush-shifting and by shifting the line connections to taps of the primary winding; the two last methods are specially applicable to the repulsion motor and to the compensated type.

Braking.—By conveniently connecting up armature, field, and regulating transformer, all commutator motors may be used as braking generators at certain speeds and voltages, the energy of the motor actuated mechanically being either absorbed by resistances or returned back to the line. The straight-series motor is best fit for being braked on resistances independently of the line, the working conditions closely resembling to the direct-current series motor. When closed on resistances, the commutator motors are single-phase self-exciting generators of variable frequency. For returning energy into the line, the motors must get the characteristic qualities of the direct-current *shunt* motor, in which case energy may be restored for a wide range of speed by varying the field strength. For decreasing speed and decreasing rotor voltage, the stator voltage must be increased by convenient transformer connections, for the direct-current series motor restoring energy is practically impossible as a special exciter becomes a necessity. The repulsion motor returns current to the line at nearly all speeds by gradually shifting the brushes over half a pole-pitch in both senses from the neutral zone. If the sense of rotation is reversed, for instance, by wide brush-shifting, braking may be effectuated by counter-current. For the repulsion motor and compensated motor brush-shifting may also be replaced by shifting the taps on the primary winding. Even when acting as generator, part of the exciting current may be drawn from the line. For all commutator motors braking may also be effectuated by exciting them separately by direct current, for instance, from a small storage battery.

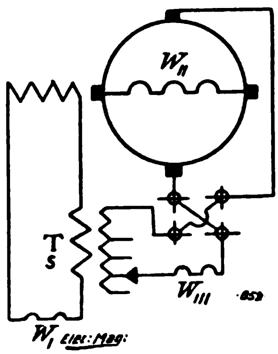


FIG. 6.

The way of braking the compensated motor on resistances is to be seen in Fig. 6 (Winter Eichberg). There are three resistances, one in each of the two armature circuits and one in the field circuit; regulating may be effectuated by the series trans-

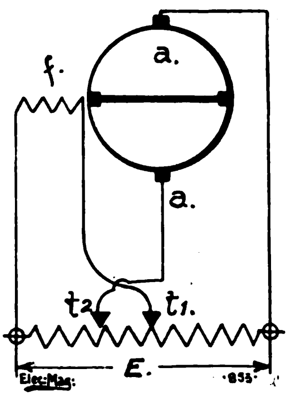


FIG. 7.

former T_s. A diagram of a compensated motor returning energy back into the line is represented by Fig. 7, E being the line voltage, t_1 and t_2 taps on a one-coil transformer by which the field and armature voltage may be independently varied at will.

Losses and efficiency.—The copper losses in field and armature are about the same for single-phase commutator motors and direct-current or three-phase motors. The following losses are, however, usually considerably larger for commutator motors than for direct current :

(1) *Iron losses*, as hysteresis and eddy currents occur not only in the armature but also in the *field*. In the armature of the straight series motor the iron losses are proportional to the larger of the two values, either to the line periodicity or to the periodicity of rotation, whilst for the repulsion motor the iron losses of the armature become zero for synchronism, increasing for positive and negative slip. At standstill the iron losses of all commutator motors are very large, whilst they are nought for direct current. At starting the iron losses may, however, be reduced by voltage transformers.

(2) The armature *crossfield* produces considerable iron losses in the series motor generally and for all motors at starting. If this field is damped away, the losses are simply transferred into the auxiliary winding.

(3) *Short-circuit losses* in the coils under the brushes which are usually largest at starting and disappear for the repulsion motor and the compensated type at synchronism. In a more general way these losses may be called ***commutator losses.***

(4) Continuous losses in *regulating transformers.*—The efficiency of commu-

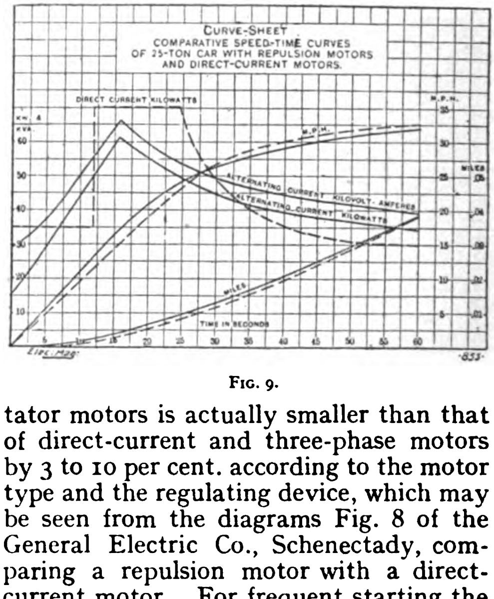


FIG. 9.

tator motors is actually smaller than that of direct-current and three-phase motors by 3 to 10 per cent. according to the motor type and the regulating device, which may be seen from the diagrams Fig. 8 of the General Electric Co., Schenectady, comparing a repulsion motor with a direct-current motor. For frequent starting the overall efficiency may be better for commutator motors than for direct-current motors, but for continuous running direct-current and three-phase motors are more efficient. Curve sheet 9 shows a comparison of the starting period of a direct-current and a repulsion-motor equipment for a 25-ton car of the General Electric Co., Schenectady. The losses in the motor itself are considerably higher at starting for the commutator motor than for the direct-current motor; the first type of motor heats therefore more when started frequently.

Whilst the maximum voltage on direct-current commutators is about 1,000 volts,

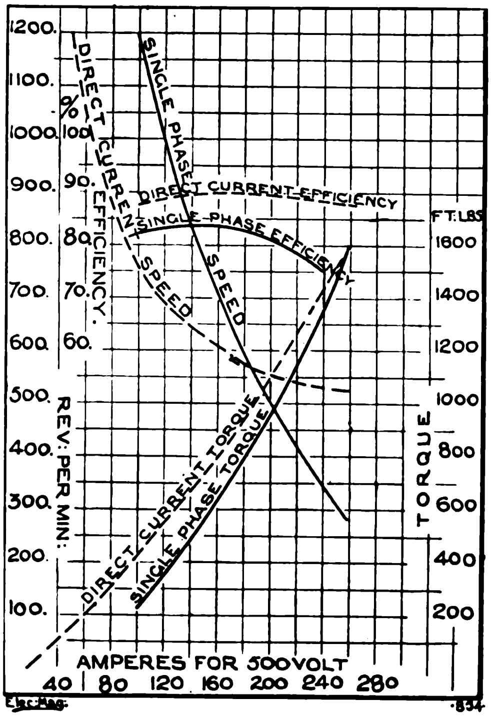


FIG. 8.

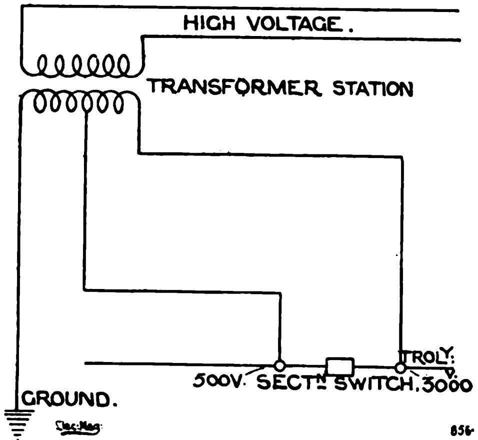


Fig. 10.

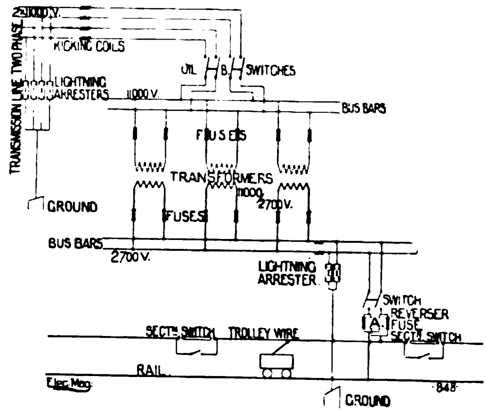


Fig. 12.

this value cannot be higher than 250 volts for single-phase motors. All commutator motors, the armature of which is not directly connected to the line, may safely be wound for voltages up to about 6,000 volts, high voltages being even safer than for three-phase motors, as all crossings of the end connections are avoided. For railways one may even apply several different voltages, for instance, 500 volts within a town and 3,000 volts outside, using a transformer on the car (Fig. 10) in the last case. The single-phase motor may even run over direct-current lines, though it should only be done in exceptional cases, as a good single-phase motor will never be a good direct-current motor, and as the starting and regulating devices will either be very inefficient or excessively heavy and expensive. See, however, a later continuation of this paper.

All single-phase motors are heavier and larger than direct-current motors of equal output by 10 to 30 per cent., the reasons being the following: For the same motor frame and flux the single-phase torque is smaller by 30 per cent. than the direct-current torque; the iron inductions must be lower for single-phase motors on account of the wattless magnetising current and on account of the iron losses; the low commutator voltage necessitates also a larger commutator. The starting and regulating devices are, as a rule, also heavier than the corresponding direct-current equipment. The question whether definite poles or a distributed winding is to be used, is easily solved. For the series motor definite poles are preferable, as the crossfield and the wattless E.M.F. is much smaller in this case, the reactance voltage is also reduced and the motor becomes cheaper; the field leakage is of course larger, but the voltage factor *c* is much better for the concentrated winding. The field voltage E_f is equal to $c.n.\ Z_f\ \Phi_f\ 10^{-8}$ n being the frequency, Z_f the total number of field conductors, Φ_f the field flux and $c = 2{,}2$ for concentrated winding, and $c = 2{,}1 - 1{,}4$ for distributed winding. For the repulsion-motor and kindred types only distributed windings are to be used as the development of the crossfield is a necessity in this case.

The generators for single-phase motors must either be single-phase and 30 per cent. larger than polyphase types, or

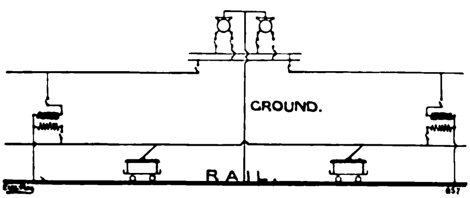


Fig. 11.

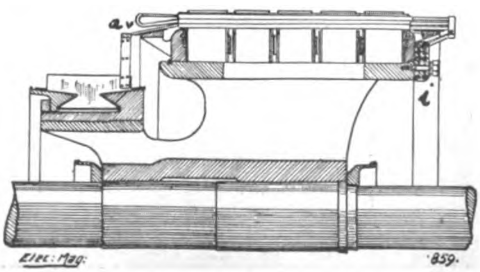
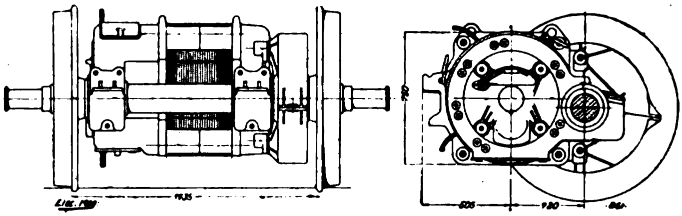
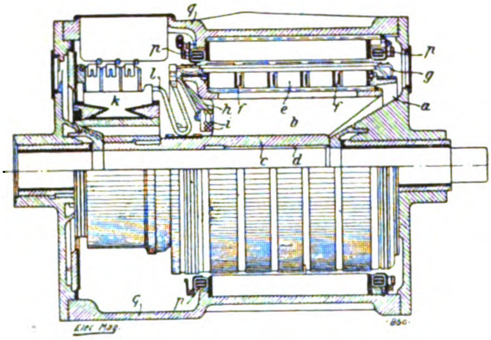


Fig. 13.



Figs. 14 and 15.



multiphase, preferably two-phase (Fig. 11), in which case it is difficult to equally load both circuits. In Fig. 11 the return conductors of both the high *and* low voltage circuit are grounded to save in line copper (Scott, Blanck). In Fig. 12 is represented the power transmission for the single-phase Stubaithalbahn near Innsbruck, built by the Austrian Union Co. Either of the two phases may be switched by B on the trolley line, both phases never being used at a time. By the inverser A either of the two wires of one phase may be connected to the track rails.

In the three last sketches, Figs. 13 to 15, some single-phase motors of actual practice are represented. Figs. 13 and 14 show the Lamme motor of the Westinghouse Electrical and Manufacturing Co. with resistance strips *l* (Fig. 14) or *a* imbedded in slots (Fig. 13) and with equaliser rings *i* (Figs. 13 and 14). The pole shoes are perforated by slots in which a damping winding is imbedded similar to the Ganz frame shown in the first part of this paper. Fig. 15 is a general arrangement drawing of a compensated motor of the Union Co., Berlin, for 120 horse-power, 700 r.p.m. and 6,000 volts.

F. Niethammer

(*To be concluded.*)

ELECTRIC FACTORY LOCOMOTIVES.

By J. F. GAIRNS.

In view of the already extensive and rapidly extending use of electricity for railway and tramway tractive purposes, it is strange that the same motive power has not been adopted to a greater degree than it has in this country, for private use about factories, collieries, &c. But on the Continent and in America a considerable business is done by engineering firms in supplying locomotives operated by electricity for transporting raw and finished material between factories and river and canal wharves and railway sidings, and for conveying parts from one shop to another at big works. There are many large manufactories abroad at which a number of electric factory locomotives are employed, and many coal, iron, gold, silver, and other mines in various parts of the world use electric locomotives, both underground and on the surface lines. Where electric power is already in use for lighting purposes and for operating machinery, the introduction of small electric locomotives in the place of steam works locomotives, or in substitution for manual and horse or mule traction, is an easy step, and may result in considerable economy, especially if natural power, such as a waterfall, is available for the generation of electrical energy. Moreover, the convenience of locomotive power in small units which do not consume fuel when not in use, and which are yet always available for work at a moment's notice, may be a very important advantage. When overhead conductors are used for supplying current, ordinary traffic on the track is not interfered with, and the passage of workmen and others about the rails is not dangerous, although there are many factory lines using a conductor rail, sometimes not protected in any way. These factory electric locomotives can be made very small, for they need not be higher above the rails than four or five feet, even with a trolley-pole and overhead conductor wire (the driver is usually seated, and only one man is employed on each locomotive), while the length, width, and weight per axle can be very limited, especially when the power of each locomotive is not required to be very great. In some cases, when a powerful locomotive is required, two machines are coupled together, and operated, according to the multiple-unit system, by the driver on one section, though each section can be used as a complete and independent locomotive when necessary.

In this article a few examples of factory locomotives operated by electricity will be described, selected from a large and varied assortment, of which the writer possesses particulars, as illustrating various designs built by firms dealing with this class of business in England, Germany, and the United States, though no pretence at thoroughness is made, the subject being such an extensive one. Moreover, electric-mining locomotives for use in coal and other underground mines will not receive attention here, except occasionally, though for this work there is very large use of such locomotives in and about Continental and American mines. In this country most coal mines have vertical shafts, "drift" mines being exceptional, and a large proportion of them are "fiery," so that electric traction cannot be safely employed, though on this question there are differences of opinion among mining engineers. Cable traction is usually employed, and in many instances locomotive traction could not be introduced in consequence of gradients and other difficulties, though even in Great Britain the use of electric locomotives for work entirely underground is not quite unknown.

In the history of electric traction the first place is occupied by the accumulator locomotive, and although in connection with electric railway and tramway practice storage systems are now never employed unless absolutely compulsory, the accumulator locomotive is still in considerable favour for factory purposes. Its general convenience, the fact that no elaborate overhead wire or third rail

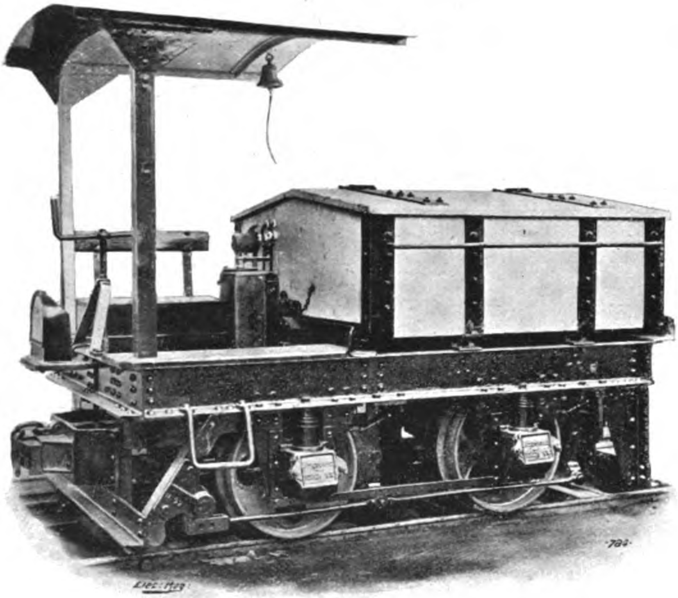


FIG. 1. ACCUMULATOR LOCOMOTIVE.
(*A. Koppel.*)

equipment is required, and that the engine can be used over a more or less complicated series of sidings, without corresponding conductor complications, all render it more suitable for use where, may be, only a single locomotive is used, and the engine is seldom or never required to go far from the generating station, while motives of electrical economy are of secondary importance. A few specimens of accumulator locomotives as employed for factory purposes will now be considered.

The firm of Arthur Koppel is well known in connection with factory contractors', and portable railways and equipments therefor, and the type of locomotive represented in Fig. 1 has been supplied by them in large numbers, notwithstanding that the makers would prefer to supply locomotives deriving current from a conductor, and users would also, in more convenient circumstances, agree with this preference. The cells usually fitted by this firm are those known as the Watt Company's dry accumulators, in which sulphuric acid absorbed by a peat material is used as the electrolite, and these cells have shown in practical use an economy and efficiency which go far to neutralise the acknowledged electrical extravagance attending the use of accumulators.

The accumulator battery consists of 44 cells, each weighing, including charge, about 43 lbs., and has a capacity of about 96 ampère hours at three hours discharge. The cells are arranged on the platform inside the wooden casing. The locomotive is designed to haul a load of from ten to fifteen tons on the level on a 3.0-gauge

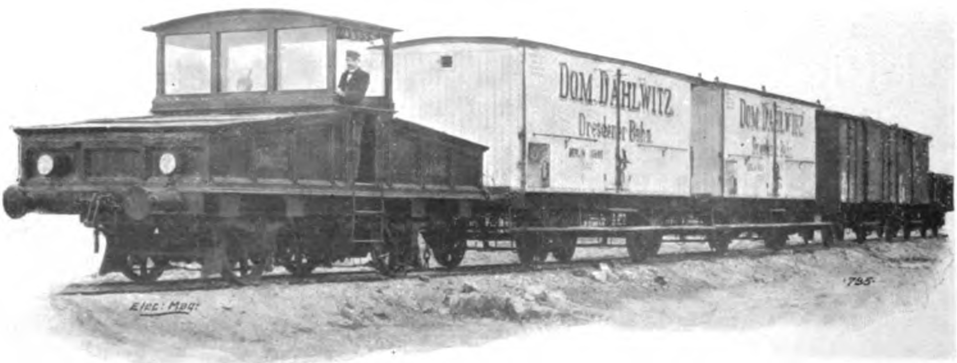


FIG. 2. ACCUMULATOR LOCOMOTIVE.
(*Siemens & Halske.*)

line. It is fitted with one 5 - h.p. electric motor of the latest traction type, the axles being driven by single reduction spur gearing. The motor develops a normal tractive effort of 350 lbs. at a normal speed of five miles per hour. The battery voltage is 110, whilst the voltage on the motor terminals is about 80 volts. The weight in working order of the complete locomotive is about 52 hundredweight.

Various modifications in external arrangement are made in different locomotives to suit circumstances and requirements, but the same general design is followed, except in large machines. For example, several locomotives have been built, in which the top of the battery casing (this may be higher than as illustrated, the cells being on two levels) represents the limit height of the engine, the driver being placed as low as possible; in other instances where height is not limited a proper cab of normal height is fitted, and the top of the battery casing serves as a platform for light goods transport.

Fig. 2 illustrates a large accumulator locomotive, built by the well-known firm of Siemens and Halske, for service in a railway shunting-yard. Full particulars of this machine cannot be given here; but from the illustration it will be seen that it is a large and powerful machine. The same general arrangement is adopted for large and medium-sized accumulator locomotives by the A. E. G. Company (Allgemeine Elektricitäts Gesellschaft), by the firm of Arthur Koppel, and by most other Continental builders, and may be considered the stock design for all except very small and special machines. A casing of carriage type, enclosing the whole machine, is, however, not uncommon, and is rather frequently adopted in American practice.

A storage battery locomotive of American design is built by the Westinghouse Electric and Manufacturing Co. and the Baldwin Works. Several more representative American examples might be selected did space allow, but in general appearance they are either of the same type as the German locomotive, shown in Fig. 2, or have a proper carriage casing. Battery's locomotives of this type are doing good service in America, and one of this particular type has now been in use for more than two years, hauling light loads at the Electric Storage Battery Company's Works over practically level tracks with curves of short radius, and during that time has given no trouble and no serious repairs have been necessary. A curious and unusual feature is, that the flanges of the wheels of locomotive and trucks are on the outer faces instead of the inner faces as usual.

Dealing now with locomotives which collect current from overhead conductors, a few representative examples will be described. As a satisfactory method of classification cannot be adopted here—for locomotives of all sizes and types have to be considered, and yet the main features, other than those due to the differing practice of various builders and designers, are the same in all—only two divisions will be recognised during the remainder of this article, viz. (1) locomotives, which are locomotives pure and simple; and (2) locomotives which have accommodation for the carriage of light goods and passengers. In both divisions the British and American examples will be dealt with first, and then the Continental ones.

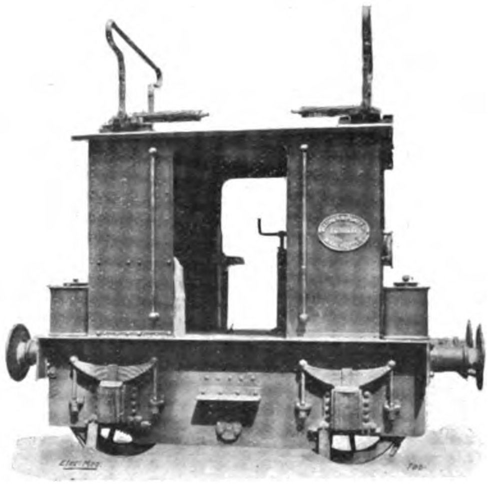


FIG. 3. SMALL LOCOMOTIVE.
(Mather and Platt.)

Fig. 3 represents an electric factory locomotive recently built by Messrs. Mather and Platt, Limited, of Salford

Iron Works, Manchester. Several locomotives of more or less similar design have been supplied by this firm to various works, British and foreign, and very good reports of their performances and general usefulness are to hand. A few particulars of the locomotive illustrated will be interesting. The locomotive works on standard gauge tracks, and can deal with a load of thirteen tons at a speed of ten miles an hour, on a gradient of 1 in 33, and proportionately for level or lesser gradients. Two reversible bar collectors are used instead of a trolley-pole for collecting current from the overhead wire, a continuous current at 500 volts being employed. The track rails are used for return. There are two motors, one on each axle, and in the cab there is a series parallel controller, an automatic cut-out, a lightning arrester, a kicking coil, and the controller resistances. The motors are entirely enclosed: they are carried partly by the axles and partly spring suspended from the frames. Single reduction gearing is employed, running in an oil-bath. In working order the locomotive weighs about five and three-quarter tons.

An electric factory locomotive is built by the Brush Electrical Engineering Co., Limited, having either a trolley-pole for collecting current, or a collector brush or shoe for third rail collection. The locomotive is provided with two motors, one driving each axle. It is adapted to work, if necessary, on rails as light as 20 lbs. per yard, and to negotiate minimum curves of 60 feet radius, while it is designed to be capable of hauling a load of 130 tons on the level, 55 tons on a gradient of 1 in 100, 35 tons on a gradient of 1 in 60, and 18 tons on a 1 in 30 grade. The line voltage employed is 500, and with the motors in parallel a speed of nine and a half miles per hour is provided for, and in series the speed is four miles per hour. The weight of the locomotive in working order is eight tons.

The same firm also build a single motor locomotive having the wheels coupled. One of these was illustrated in THE ELECTRICAL MAGAZINE for April, page 414.

Fig. 4 illustrates a locomotive recently

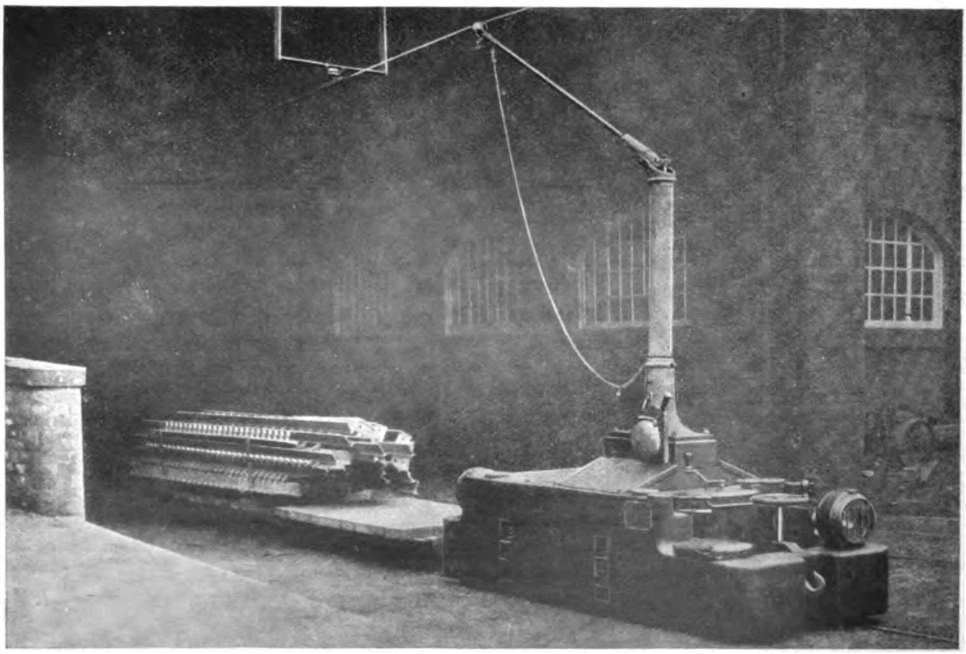


FIG. 4. FOUNDRY LOCOMOTIVE.

(*B. T. H.*)

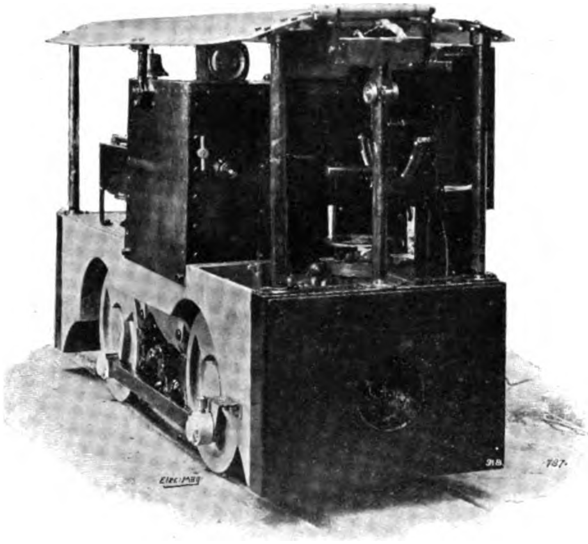


FIG. 5. MINE LOCOMOTIVE.
(*Scott and Mountain.*)

at about 750 revolutions per minute, driving through treble-threaded machine-cut spur gear on to one of the axles, while the other axle is driven through coupling rods. The requisite fittings, switches, resistances, &c., are of this firm's standard types. Other features of the design are shown in the illustration. Current is collected by means of the collector roller shown from an overhead conductor rail.

Fig. 6 illustrates a locomotive recently supplied by Messrs. Dick, Kerr, and Co., Ltd., for service at the works of the British Insulated Wire Company. The gauge of rails is 18 in., and the locomotive, supplied to Messrs Platt Bros., for use at their works at Oldham, by the British Thomson-Houston Co., Ltd. The design is rather curious, and the principal external features are well shown in the illustration. The locomotive weighs 9,500 lbs. and exerts a draw-bar pull on the level of 1000 lbs. at eight miles per hour, with a supply voltage of 200. The gauge is 2 ft. 6 in., wheelbase 37 in., wheels 22 in. diameter, width over all 3 ft. 8¾ in., and height of frame above rails 28 in. The two motors are of the standard traction type of this firm, and are arranged tandem.

Fig. 5 depicts an electric locomotive designed for contractors' use by Messrs. Ernest Scott and Mountain, Ltd., of Newcastle-on-Tyne. The locomotive is capable of drawing a gross load of eight tons at about six miles per hour, and at slower speed it can deal with this load on a 1 in 30 grade. The motor is of 15 effective h.p., and normally runs

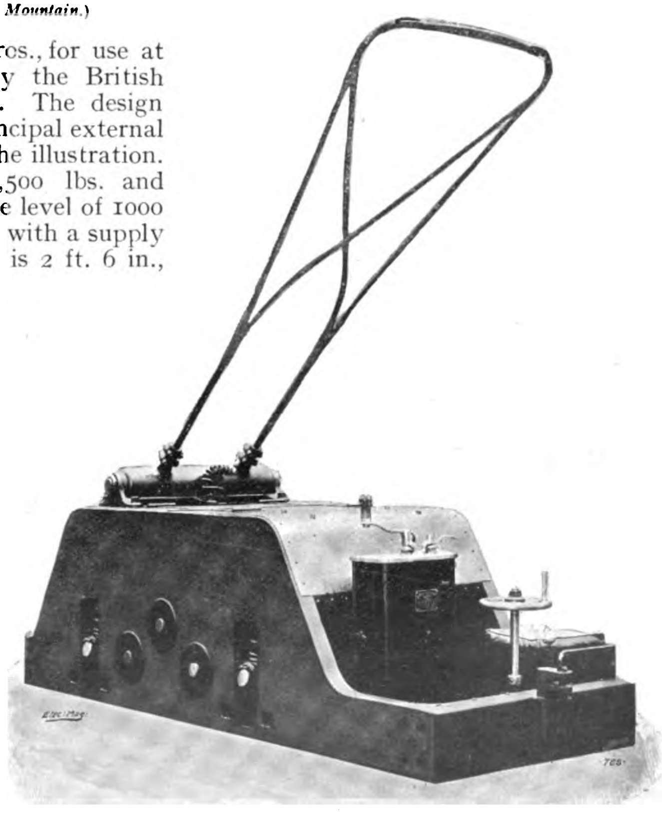


FIG. 6. SPECIAL LOCOMOTIVE.
(*Dick, Kerr.*)

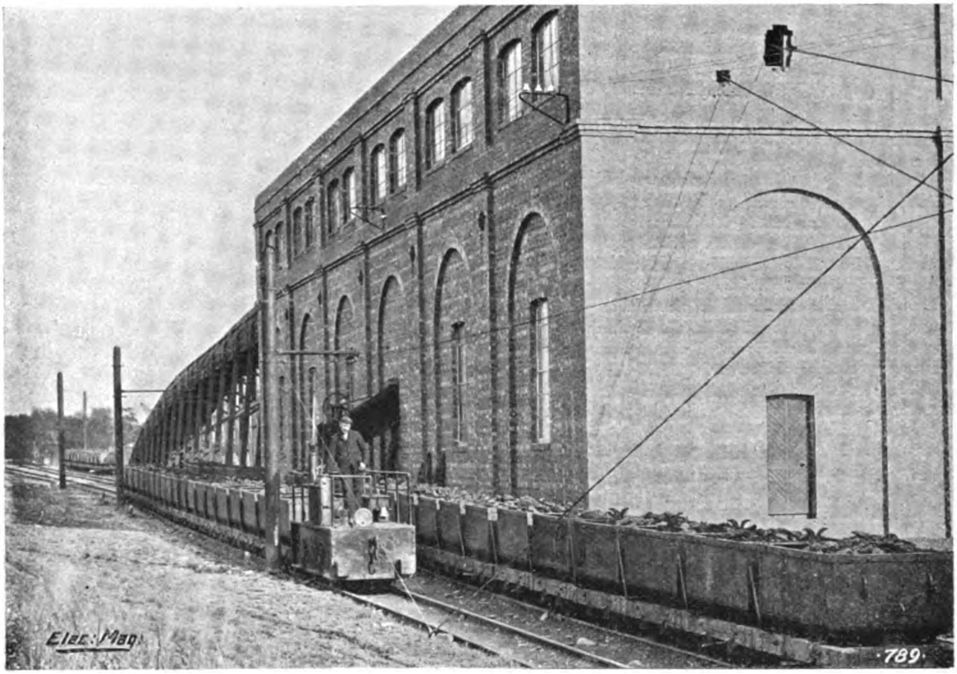


FIG. 7. LOCOMOTIVE IN OIL-MINE.
(British Westinghouse Co.)

which has a wheel base of 44 in., is propelled by a single motor geared to the driving-wheels through double reduction gearing of 14 to 53 and 21 to 55, this being equal to a gear ratio of about 1 to 10. The driving-wheels have a diameter of 21 in. The motor, which is series wound, is rated to give an output of 15 h.p. at a terminal

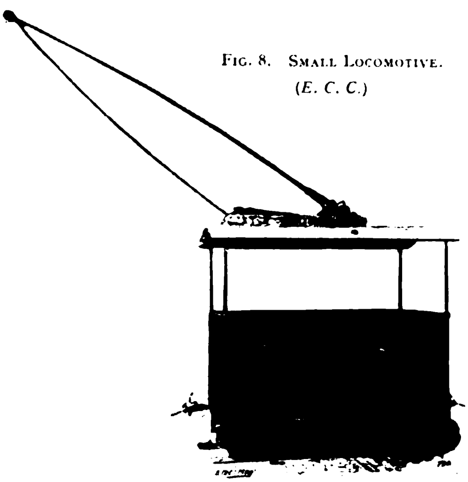


FIG. 8. SMALL LOCOMOTIVE.
(E. C. C.)

pressure of 220 volts, the rating being based on standard railway practice, that is, after one hour's run at rated load, the temperature of the motor winding shall not rise more than 75° C. The rheostat controller is of the builders' standard railway type, and is designed to control the motor at six different speeds. The trolley is of the sliding bow type, the sliding surface being of soft white metal, adapted for easy renewal. The total weight of the locomotive is about 2¼ tons.

Fig. 7 illustrates an electric locomotive recently supplied by the British Westinghouse Electric and Manufacturing Co., Ltd. for use at the Duddingston Shale-Mines and the Niddrie Oil Works of the Oakbank Oil Company in Scotland. The locomotives are employed for conveying material between the mines and the works, a distance of about two miles, and are adapted to deal with loads of about forty tons at an average speed of ten miles an hour. Current is supplied by overhead conductor wires at 400 volts and collected by a trolley-pole on the locomotive. The constructional features of the locomotive are of the usual Westinghouse

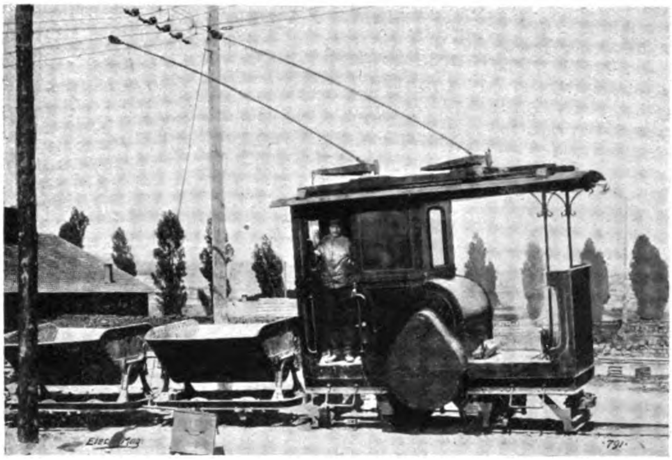


Fig. 9. Locomotive with Two Trolleys.
(*Brown, Boveri and Co.*)

lighting, the locomotive haulage is found to result very economically.

The locomotive illustrated in Fig. 8 is one built by the Electric Construction Co., Ltd., of Wolverhampton, for outdoor working, such as in large works and factories, and it has been used in some cases for mines. It is fitted with one motor, which drives both sets of wheels through double reduction helical gearing. Its duty is to pull a load of about four tons up an incline of 1 in 20 at a speed of about six miles an hour, and to do about ten miles an hour light. The gauge is only 2 ft. and the wheel base about 30 in. The top portion of the frame is easily removed, so that in case of any repairs no difficulty is experienced in getting at the working parts. For hot climates and for protection against bad weather, blinds

standards, but the upper work is arranged so as to provide a platform, the unoccupied portion of which can be used for the transport of light goods. As there is an extensive electric installation at these works, supplied from a central power station, for underground and surface cable haulage, winding, ventilating, and

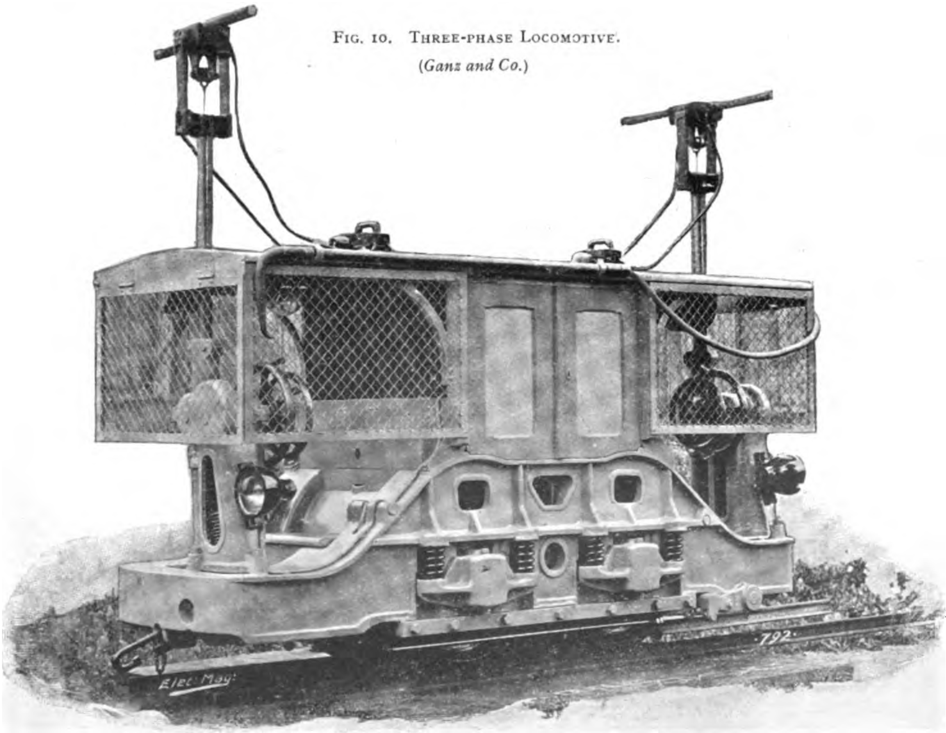


Fig. 10. Three-phase Locomotive.
(*Ganz and Co.*)

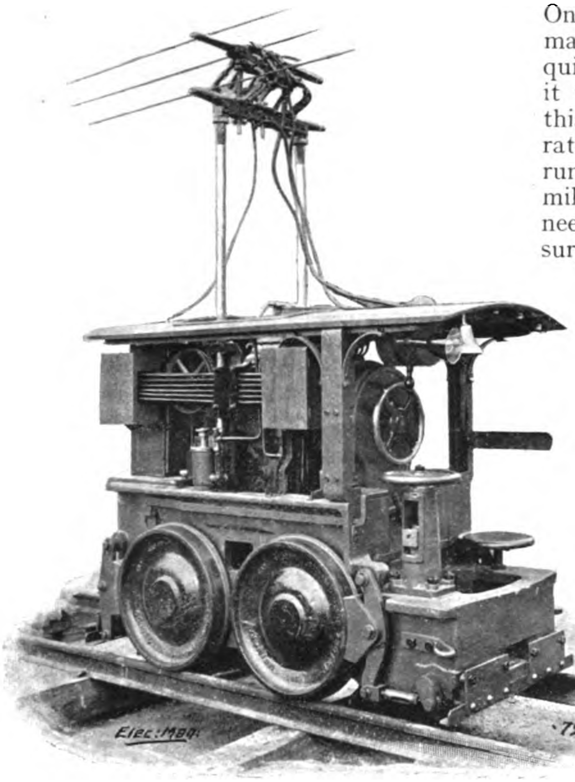


Fig. 11. Three-phase Locomotive.
(*Ganz and Co.*)

are provided at the sides, which can be raised or lowered at will. To illustrate the kind of work expected with these locomotives, the builders quote the following incident from actual experience. "Complaints were made that the motor armature connections were constantly breaking, and on inquiring into the matter we were informed, quite as a matter of form, that the work the particular locomotive in question had to do was to start a big load of trucks on the level, which required somewhere about 100 ampères (the normal of the motor being 30), and then haul these trucks down an incline for a distance of as near as possible a mile. One day the electrician in charge, as a matter of curiosity, checked the time required to perform this journey, and found it took just one minute. When relating this to us we were informed that this was rather a higher speed than they usually run, but that speeds of from forty to fifty miles an hour was the regular thing. We need scarcely add that we were not then surprised to learn of the breakage of the commutator connections." This firm also build small locomotives of limited dimensions for working in and about mines, quarries, &c., and large locomotives for railway shunting purposes, some of them being designed for use with storage batteries.

The Goodman Manufacturing Co. of Chicago, U.S.A., also build a locomotive for surface haulage. It is really an adaptation of their standard design for mining purposes for use where headroom is not limited, a cab casing being fitted for the accommodation of the driver.

The Baldwin-Westinghouse, General Electric, H. K. Porter, American Locomotive, and other American Companies build various designs for surface traction, but these cannot be illustrated here, and would be largely repetitions so far as

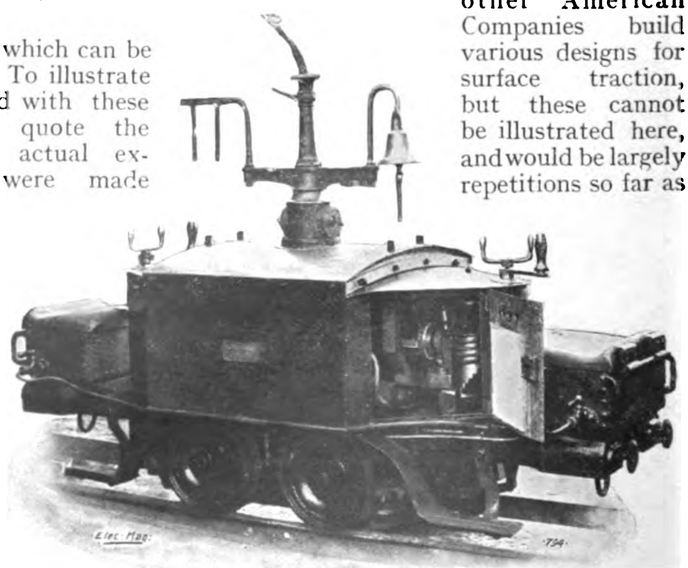


Fig. 12. Small Factory Locomotive.
(*Siemens and Halske.*)

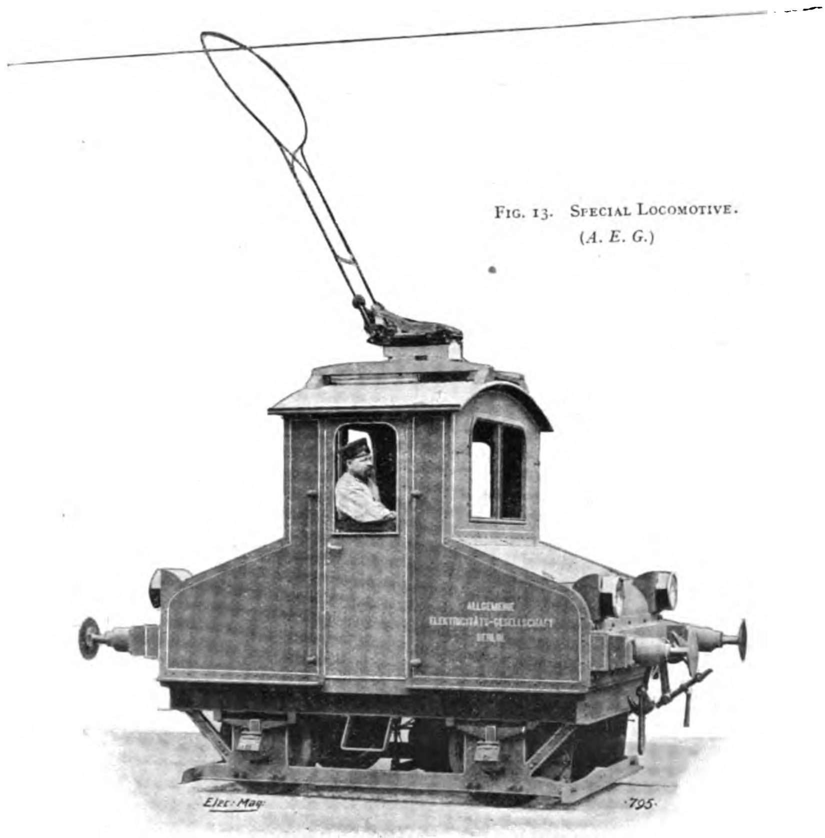


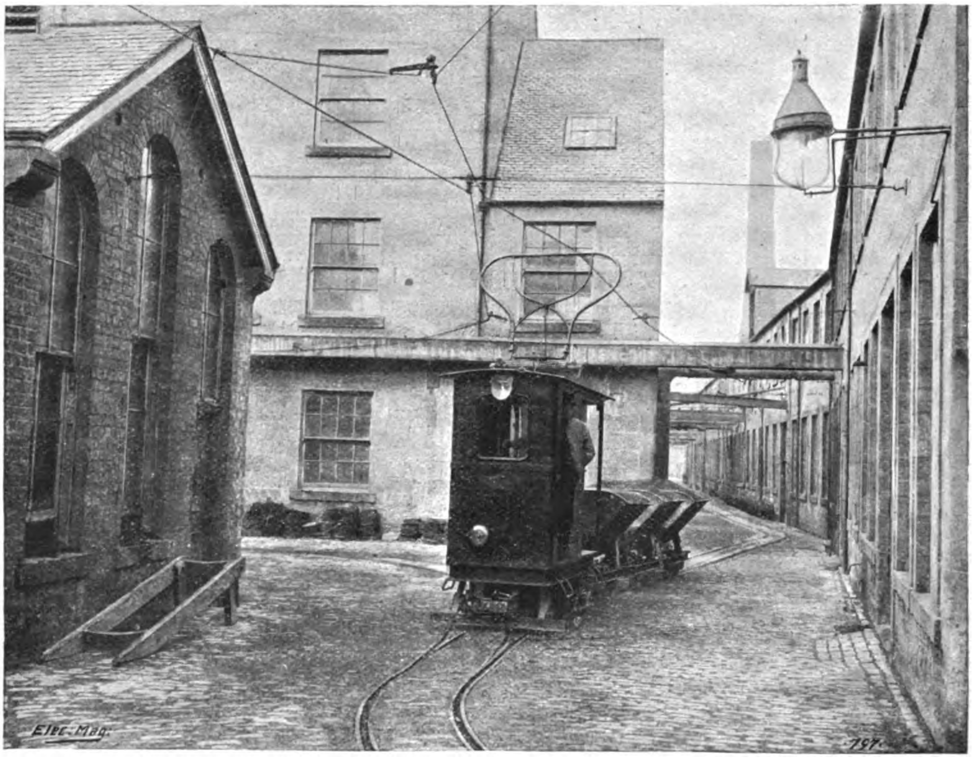
FIG. 13. SPECIAL LOCOMOTIVE.
(*A. E. G.*)

outward appearance is concerned. In some cases double conductor wires are employed and two trolley-poles fitted, one for collecting current and the other for return instead of using the rails.

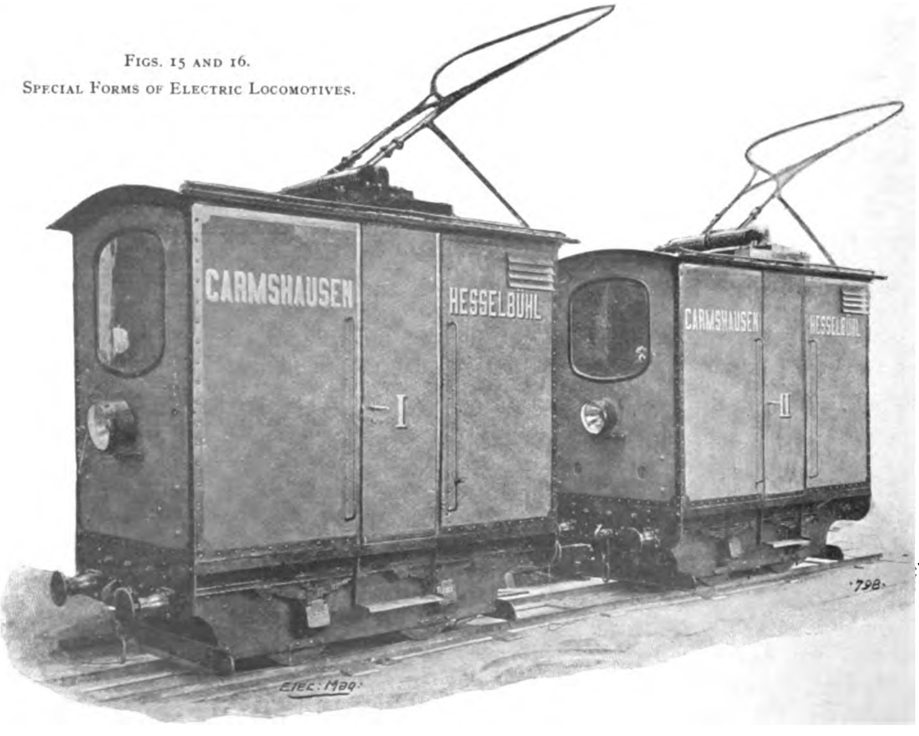
Fig. 9 illustrates a locomotive built by the Swiss firm of Brown, Boveri, and Co. for use at the Bexbach Tile Works in Germany. The locomotive works on 2 ft. gauge lines with three-phase current at 500 volts. The motor generates about 35 h.p. in ordinary work.

Another three-phase locomotive is represented in Fig. 10, built by the firm of Ganz and Co. of Budapest for use at the Royal Hungarian Iron Works. The locomotive, which weighs about 3½ tons, works on lines of almost 2 ft. 6 in. gauge, and takes three-phase current at 500 volts from two overhead conductors with rail return. The motor drives both axles by double reduction gearing. As will be seen from the photograph, netting is fitted to protect the driver in case of the breaking of a conductor wire. The double collector shoes are of a peculiar type, and their design is in accordance with the special electrical practice of this firm.

A locomotive built by this firm for a French mining company is illustrated in Fig. 11, and, as will be seen, there are many unusual features. Most of them cannot be dealt with in detail, but it may be stated that the current collector is so constructed that it serves the purpose of two collectors, the top bar touching one wire, either on the left or right according to the location of the wire, and the lower bar similarly contacting with the other wire. In this case the collector also contacts with a third wire, the rails not being used for return. The writer possesses particulars of several other Ganz locomotives, all of which would be of interest as they differ considerably from the general practice.



FIGS. 15 AND 16.
SPECIAL FORMS OF ELECTRIC LOCOMOTIVES.



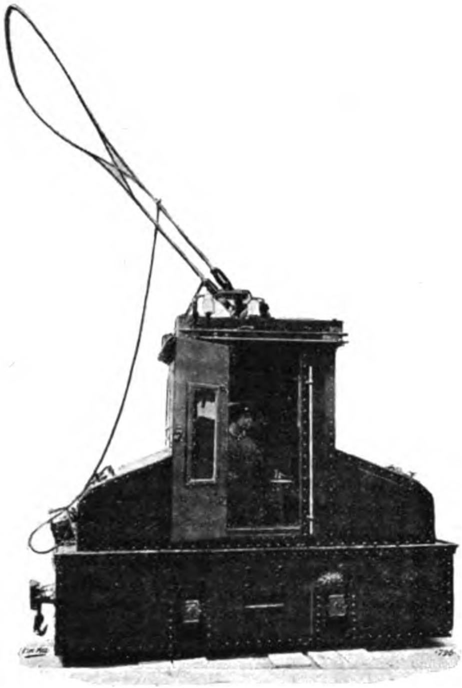


FIG. 14. SPECIAL LOCOMOTIVE.
(*Lahmeyer.*)

Since 1882 the well-known German firm of Siemens and Halske have been building electric locomotives for mining and factory purposes in large numbers, of various types, many of which possess very interesting features, but only a selected few can be described here. A small factory locomotive is shown in Fig. 12. The motor is arranged longitudinally, and drives by bevel gearing a vertical spindle which is geared with the axles, as can be seen through the open casing door. The locomotive is double-ended, duplicate seats and controlling handles, &c., being provided at each end, the driver occupying a seat at one end or the other according to the direction of travel. A trolley-pole for collecting current is mounted on the centre pillar.

The locomotive illustrated in Fig. 13 is a specimen of work done by another large German electrical firm, the Allgemeine Elektricitäts Gesellschaft, of which the Electrical Company of Charing Cross Road, London, are the British representatives.

Fig. 14 represents one design as built by the Lahmeyer Electrical Company, Ltd., of New Oxford Street, London. This illustrates a very convenient type, of which considerable numbers have been supplied. A very similar design is also adopted by the A. E. G. Company.

Dealing now with locomotives designed to accommodate a few passengers and to serve for the transport of light goods, two examples are illustrated in Figs. 15 and 17.

Fig. 15 shows a locomotive, part of which is an open platform, recently built by the firm of Arthur Koppel for use under circumstances which caused more than one British firm to decline the order. The electric locomotive is used for coal transport and for conveying materials from one shop to another at the Levenbank Works of the United Turkey-Red Company at Jamestown, near Balloch, N.B. The gauge of track is 2 ft. only, double rails of tramway type being used to allow of cartage traffic, and there are several sharp curves and steep grades, one curve of 10 ft. radius being on a gradient of 1 in 30. The locomotive has a driver's

FIG. 17. PLATFORM LOCOMOTIVE.
(*A. E. G.*)

cab and an open platform, which can be used for the transport of material. A spring-supported $7\frac{1}{2}$-h.p. motor is used, which drives the front axle by single reduction gearing, the rear wheels being driven by coupling rods. The weight of the locomotive is thirty-eight hundredweight. Current is collected from an overhead conductor by means of a bow collector. The figure illustrates this locomotive at work, and from it some indication of the awkward circumstances which required consideration can be obtained.

Fig. 16 illustrates a rather curious design adopted by the Lahmeyer Co., the two locomotives being adapted to accommodate workmen proceeding to and from work. Apparently the unfortunate employees are to be prevented from surveying any scenery there may be, except what can be seen through the end windows over the motor-man's shoulders. Fig. 17 illustrates a platform locomotive, built by the A. E. G. Company, in which seating accommodation is provided. Various other combinations have been provided by different builders, such as a locomotive built by the firm of Arthur Koppel, having the driver's cab in the centre with the end portions constructed similarly to a railway goods waggon and combined electric locomotives and cranes.

From the foregoing it will be seen that a vast field of usefulness exists for the electric locomotive in connection with the needs of large factories and construction works. Already a considerable amount of work has been done by various firms in catering for industrial requirements in this respect, and specimens of their productions have been described and illustrated; and it is probable that in the near future there will be extensive developments of this application of electric tractive motive power. The specimens of British practice described in this article are interesting, though British work in this connection is as yet very limited; and the foreign examples will serve to indicate the possibilities and probabilities for both present and future work.

We express our thanks to the various firms, British and foreign, who have supplied photographs and particulars of their locomotives for the purposes of this article.

J. F. Gairns

IMPORTANT NOTICE.

*The issue of our **Souvenir St. Louis Number** is postponed until January next.*

The original scheme has required considerable extension to adequately cope with the matter brought back by the Editor-in-Chief.

This has been decided upon in our readers' interests, and the number will justify the course now adopted.

The January number signalises the first anniversary of this journal, and the consequent interest in this double event augurs well for a record sale and an unprecedented success.

We direct attention to the Editorial and to the other announcements concerning the Souvenir issue elsewhere in this issue.

Readers are referred to the World's Electrical Literature Section at the end of the Magazine for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

Power Matters before the Congress.

By the ASSOCIATE EDITOR.

THE power matters discussed before the International Electrical Congress turned mostly on the subject of transformers and transmission lines This is quite natural, seeing that the design of generating plant has already become standardised and greater attention is necessary for accessories such as those mentioned. In our last issue we referred briefly to the chief papers read, and now with these papers before us we can not only summarise but go more into detail. Signor E. Bignami, in an extensive survey, gave valuable statistics on Swiss practice in power-plants, stating that the usual frequency was fifty cycles, and that a number of direct-current systems were in use. On the whole, the methods adopted were not so uniform as those prevailing in America. In the absence of Signor Bignami the paper was abstracted by Dr. Louis Bell. In discussing the paper the chairman, Mr. C. F. Scott, was struck with the great number of plants in so small a country. Dr. Perrine remarked on the good load factor obtained, this being frequently over 50 per cent.; it was a matter creditably reflecting on the management and showed shrewd attention to detail. The chairman expressed regret at being unable to compile a history of long-distance power work in California, but presented instead an account of the first transmission work done in America.

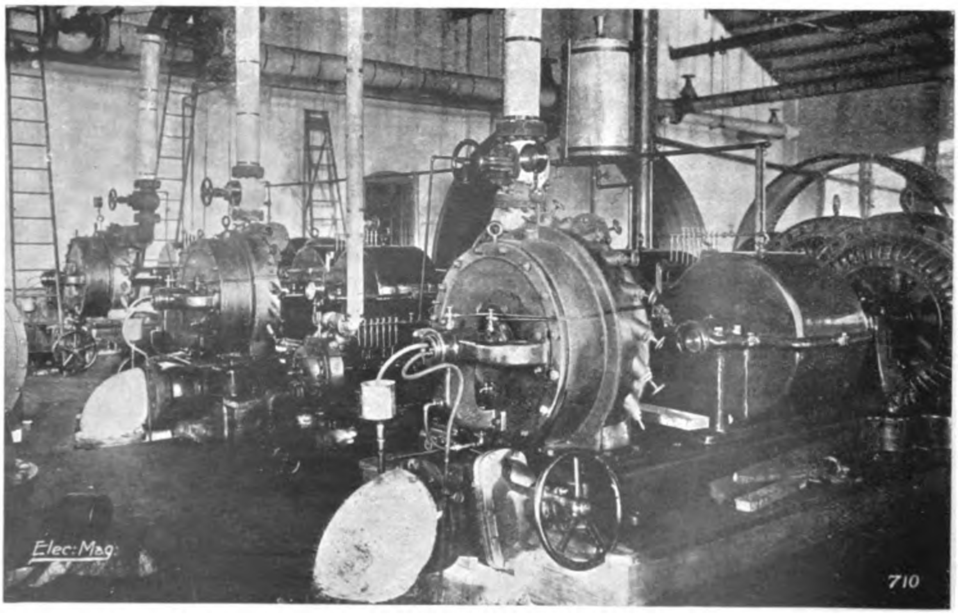
The subject of transformers and the respective merits of the oil-cooled and air-blast types was recently discussed with considerable vigour before the American Institute. Mr. J. S. Peck, in his treatment of transformers for high-voltage transmission lines, though not directly raising the question, again evoked criticism of an almost identical character; as to the oil type, he considered it presented little or no additional fire risk, as the oil was only inflammable at high temperatures. Curves of increase in output manufacture and voltage were given, from which we learn that pressures of 3,000–10,000 volts common in 1893 had risen to 20,000–60,000 volts in 1903. Discussion was not in accord with certain statements in the paper, Mr. F. O. Blackwell disagreeing on the matter of fire risk with oil transformers. The presence of so much oil resembled the storage of oil in a warehouse, and should be subject to equal precautions against fire. Transformers should be in air-tight and fire-proof compartments. He further remarked on the high cost entailed by high efficiencies. A 96 per cent. transformer would cost half the usual amount needed for one of 99 per cent. efficiency. Mr. E. K. Scott, inquiring as to the advantage of cooling ribs inside the tank as well as outside, elicited information that inside ribs were valueless, as the oil gave up its heat more quickly to the case than to the external air. Dr. Louis Bell advocated plenty of space around apparatus as the best form of insurance. Mr. Blackwell, referring to the quality of the oil, said its insulating properties were often impaired after leaving the factory. Oil which was defective in this was on one occasion restored by pumping hot air through it. Mr. Peck, in reply, said that transformer oil must be mineral oil bought under rigid specifications as to freedom from moisture, acids, and alkalies.

Mr. F. G. Baum, in a valuable paper on

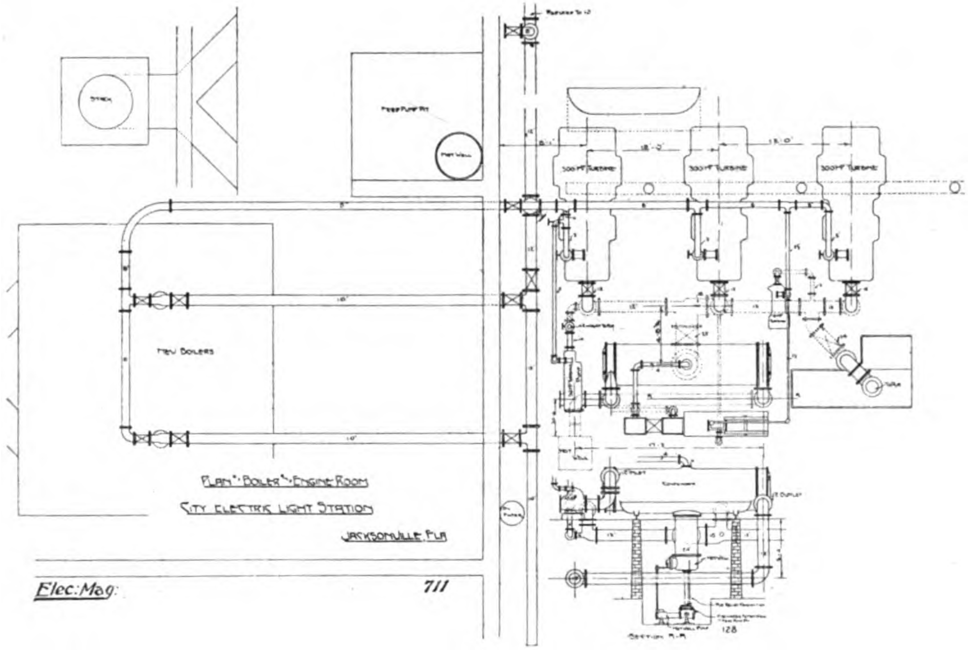
High-Potential Long-Distance Control, gave equations determining the charging currents for three-phase lines, and the inductance pressure due to any chosen current. He further investigated the pressure rises due to charging currents and the surges occasioned by opening a loaded or short-circuited line. A description was given of the 50,000-volt insulator used on 700 miles of line in California. Advantage had been taken there of hills and ravines to put up long spans, these often extending to 1,800 ft. with aluminium wires. Lightning troubles were minimised with higher voltages and voltage rises due to surging were also less. Replying to queries, he stated that the air gap of a horn-type lightning arrester for 60,000 volts was 4 to 4½ in. between each leg and ground. Mr. Baum referred to the extreme flexibility of his company's system (in California), quoting an instance of a generator, in a power-house under repair, being started as a synchronous motor to supply lagging currents for counteracting the condenser effect of a 350-mile line, at the end of which the disabled power-house was located. Mr. H. W. Buck, in his paper on Aluminium as an electrical conductor, said that early troubles due to breakage were now obviated by the use of a stranded conductor. A paper on High-Tension Insulators by Mr. V. G. Converse stated that modern insulators were very heavy, some for 60,000 volts being 14 ins. diameter and weighing 25 lbs. For higher potentials and longer spans future insulators might weigh several hundred pounds. Chairman Scott pointed out that the cost of insulators was but a small item of plant expense. He quoted a case where fixed charges on insulator investment were found to be but 20 per cent. per kw. per year.

A New Municipal Steam Turbine Plant in Florida.

At Jacksonville, Florida, the city has installed an up-to-date steam turbine electrical generating plant to handle the heavy demands for electric power and lighting service. The steam turbine was decided upon as the best prime mover to be employed, as the available space was limited and the cost of enormous reciprocating steam-engine foundations would be very high on account of the peculiarity of the soil in the locality of the municipal plant. The boiler-house was equipped with two boilers of the Babcock & Wilcox type, and a steel stack five feet in diameter and 100 ft. high provided for supplying the natural draught. The boilers are each fitted with a superheater for a working pressure of 300 lbs. and 100 degrees Fahr. This high pressure combined with the superheat provided are well adapted for steam-turbine service. A steam-turbine pump is utilised to supply circulating water, and a condenser and vacuum-pump have been installed, steam turbines being used as prime movers except in the case of the vacuum-pump.



View of Turbines, Jacksonville.



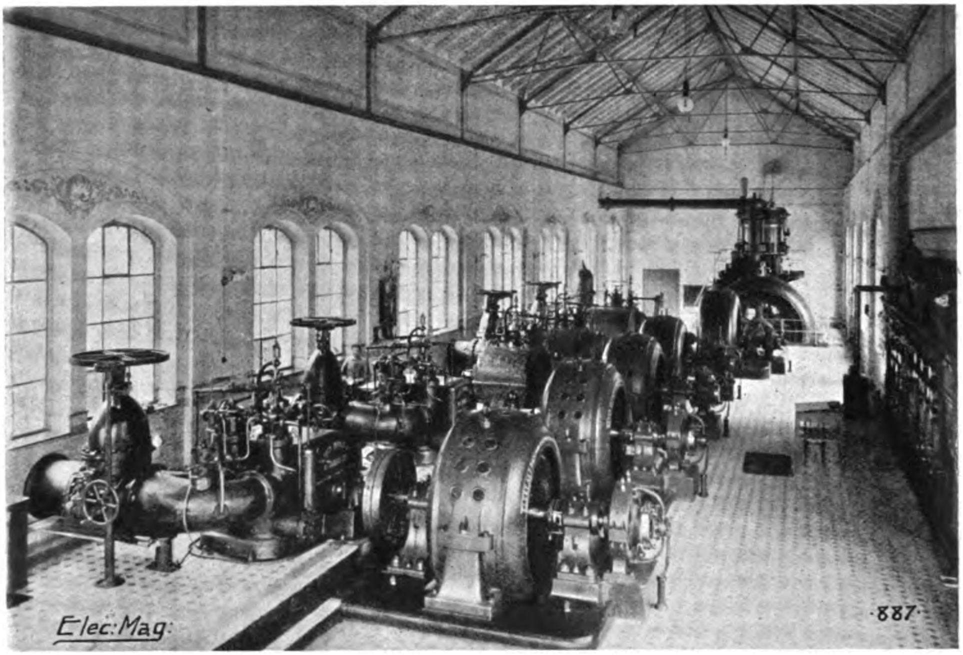
PLAN OF JACKSONVILLE STATION.

There are two 300 h.p. De Laval steam turbines in operation, being directly connected to Bullock 200 kw. 3-phase alternators. The twin alternators are designed for a 2,300 volt current and 7,200 alternations per minute. Provision has also been made for installing a direct current generator of 500 volts pressure and 200 kw. capacity directly coupled to another 300 h.p. steam turbine of the same type. The plant was installed by the D'Olier Engineering Co. of Philadelphia, Pa, and is located near the centre of Jacksonville. The feeders extend from one to two miles in each direction from the power-house, the alternating current circuits being utilised for arc and incandescent lighting, and the direct-current circuits for operating elevator motors and commercial power service over about two square miles. In addition to the steam turbine electric plant there are a number of monocyclic alternators of 150, 200, and 250 kw. capacity as well as several arc light dynamos of the Brush type each supplying 125 lights of 2,000 candle-power each. The engines operating these dynamos include two Hamilton Corlis tandem compound engines each having a capacity of 350 h.p. and one Corlis cross compound engine of the Filer-Stowel type of 750 h.p. These engines are supplied with steam from a 350-h.p. Caldwell boiler and several Babcock & Wilcox boilers of the same capacity. The condenser used is of the Alberger type, capable of condensing 15,000 lbs. of steam per hour, while maintaining a vacuum of twenty-eight inches with thirty-inch barometer.

The accompanying illustrations show the arrangement of the turbines and generators. The switchboard consists of three panels of Tennessee marble, each panel being provided with the usual instruments.

The Kubel Hydro-Electric Plant.

THE Kubel hydro-electric plant is supplied with water by a steel pipe 294 meters in length. Some of the largest hydro-electric plants in Europe find it necessary to instal auxiliary steam equipments for helping out during time of low water A reserve steam-plant of 1,000-h.p. capacity has been provided at Kubel supplying current for from 30 to 50 days when the water-power is not sufficient to take care of the existing load. The hydraulic plant includes four turbine sets of 500 h.p. each and two turbine sets of 1,000 h.p. each, while the auxiliary steam-plant consists of one vertical compound engine of 1,000-h.p. capacity directly coupled to an 850-kw. dynamo operating at a speed of 150 r.p.m. The steam-engine and the hydraulic turbine were installed by Escher, Wyss, and Co. of



ENGINE ROOM, KUBEL POWER PLANT.
(STEAM PLANT IN BACKGROUND.)

Zurich, Switzerland, while the electrical equipment was supplied by the Elektricitets-Actien Gesellschaft, formerly W. Lahmeyer and Co. of Frankfort, Germany. The 500-h.p. hydraulic turbines operate at a speed of 375 r.p.m. and are directly coupled to 400-kw. alternators which supply a three-phase current of 10,100 volts directly from the windings of the generator. These machines are of the revolving-field type, having 16 poles. The outside diameter of the armature is 6 ft. 2 in., while the inside diameter is 4 ft. 9 in., the width being 1 ft. 3 in. including the ventilating device, while there are in all 96 slots for the winding. The 1,000-h.p. hydraulic turbines are directly coupled to two 850-kw. three-phase machines having 20 poles and operating at a speed of 300 r.p.m. One of these machines may be noted in the background in figure just in front of the steam-driven unit, while the four machines in the foreground are of 500 h.p. each. The 850-kw. machine has 120 slots in the armature, the width being 1 ft. 4 in. and the inner diameter 7 ft. 1 in., while the outer diameter measures 8 ft. 7 in. The vertical compound engine has a stroke of 29 ins., the high-pressure cylinder having a diameter of 27½ ins., and the low-pressure cylinder 43½ ins. It operates at a speed of 150 r.p.m. and is supplied with superheated steam at 280 degrees. The boiler plant includes two water-tube boilers each having a heating surface of 2,700 sq. ft., and each provided with a superheater of 650 sq. ft. heating surface. The boilers operate at a steam pressure of 140 lb. per sq. in. and measure 4 ft. 6 in. in diameter and 22 ft. in length. They are provided with 171 tubes, each having an outer diameter of 3¾ in. and a length of 16 ft. The engine is directly coupled to the revolving fly-wheel field magnet of the 850-kw. alternator which has 40 poles. The armature has 240 slots and is 12 ins. wide. The inner diameter of the armature is 10 ft. and the outer diameter is 11 ft. 6 in., while the total outside measurement of the generator is 13 ft. 6 in. The exciter for this unit is a multipolar direct-current dynamo mounted on the outside of the main bearing of the alternator. The current is transmitted by overhead lines at a pressure of 10,000 volts and is transformed at the sub-station to 550 volts for the secondary power circuit and to 125 volts for the lighting distribution. The current is sold for power purposes at the rate of 400 francs per horse-power per year for a small machine, 275 francs per horse-power per year for machines of 10-h.p. capacity, and at 180 francs per year for motors of 50 h.p. or over.

Sofia Hydro-Electric Plant in Bulgaria.

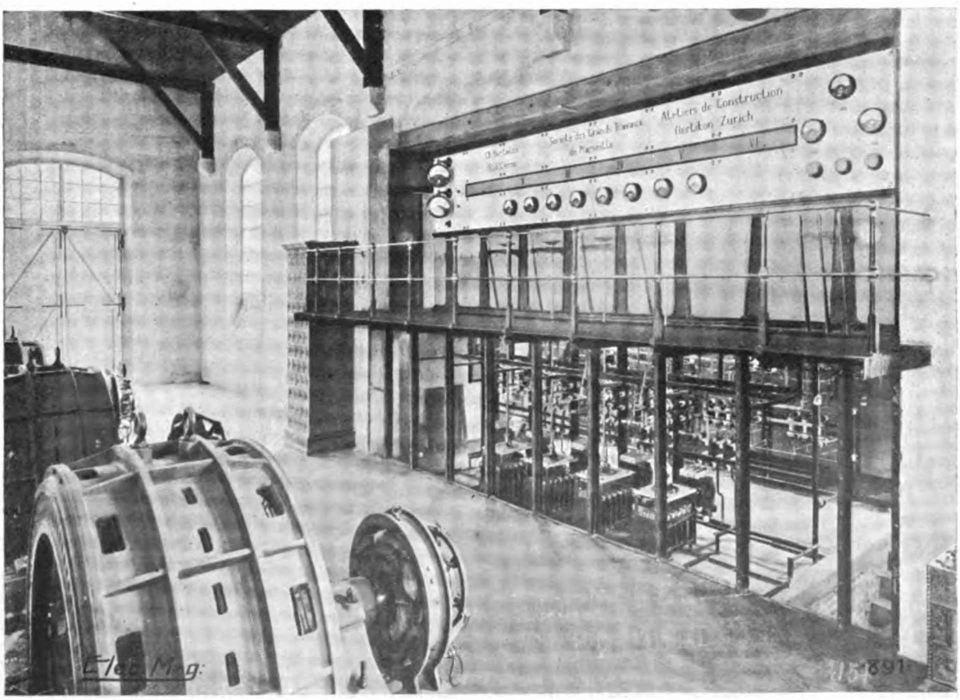
THE "Société des Grands Travaux de Marseille" owns and operates the Sofia electric power station. It was installed by the Maschinenfabrik Oerlikon of Oerlikon, Zurich, Switzerland. Water power is obtained from the Isker river, and the accompanying illustration shows switch gear in this power station.

The total capacity of the plant at present installed is 2,000 h.p., while there is a total of 3,000 h.p. available. The reservoir has a capacity of 150,000 cubic metres, and the normal supply of water from the Isker river is 5 to 6 cubic metres per second. The conducting pipe is 120 ft. long and the power house is located a distance of 13½ miles from Sofia.

There are four turbines directly connected by flexible insulated couplings to the generators. These turbines were constructed by Piccard, Pictet, and Co. of Geneva, Switzerland. They have each a capacity of 500 h.p. and operate at a speed of 400 r.p.m. The total discharge of water is 960 litres per second with a net fall of 52 to 55 metres, the efficiency being 75 per cent. The turbines are regulated by a special governor mounted on top of the casing and driven by belt from the main shaft. A special hydraulic regulator is employed for moving the gate. The generators are mounted on 44 porcelain insulators for insulating them from the foundation. They are of the Drehstrom type, 425 kw. each, and operate at a pressure of 8,000 volts 53 periods. The armature has 48 slots, and each armature coil has 65 turns of copper wire 3.4 mm. in diameter. These coils are insulated with micanite from the iron core. The field magnet has 16 poles and each of the field coils have 110 turns of copper wire 7 mm. in diameter. The excitors are four pole direct-current machines of 9 kw. 50 volts directly connected to the main shaft of the alternator outside the main bearing.

The switchboard is mounted on a gallery constructed of iron and steel, and includes eight panels upon which are mounted the usual ammeters, voltameters, and other measuring instruments, while the switches are controlled by levers and wheels as shown, extending through the gallery floor.

The primary transmission line is 10 miles in length, and connects the power house with the transformer sub-stations in the city. The transformers are of the step-down



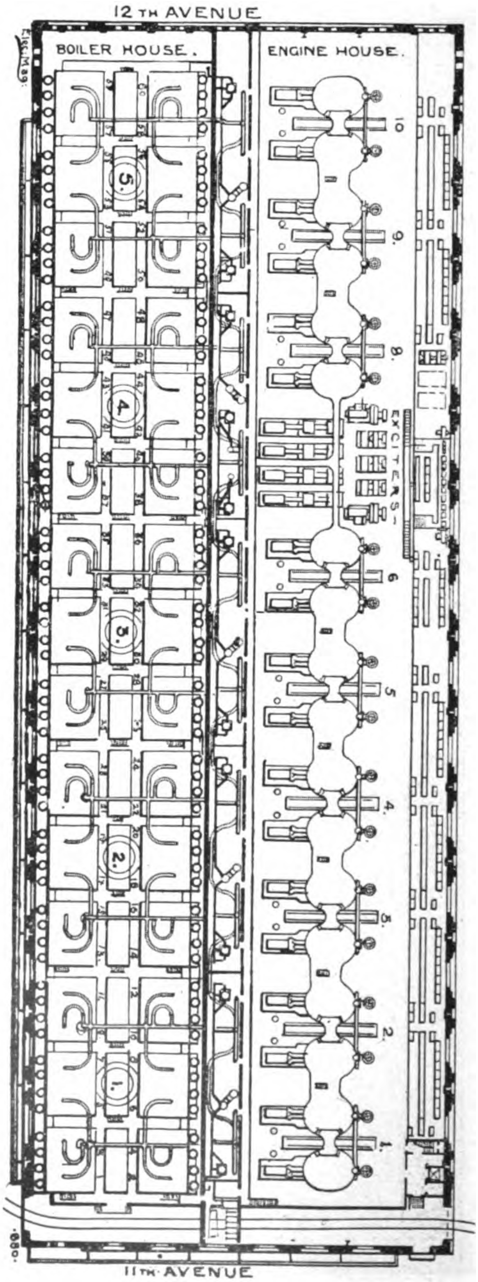
GENERATORS AND SWITCHBOARD, SOFIA.

type which reduce the 7,200 volt primary pressure to 156 volts for the secondary distribution. One of these sub-stations located outside the city limits is equipped with transformers of 400-k.w. capacity and several others equipped with transformers of 260-kw. capacity are located at various points within the city. One of the transformer stations which has a capacity of 270 k.w. reduces the transmission-line pressure from 7,200 volts to 3,400 volts, and there are two other transformer sub-stations equipped with motor generators for supplying direct current to the electric railway and to the Palais du Prince-Regnant.

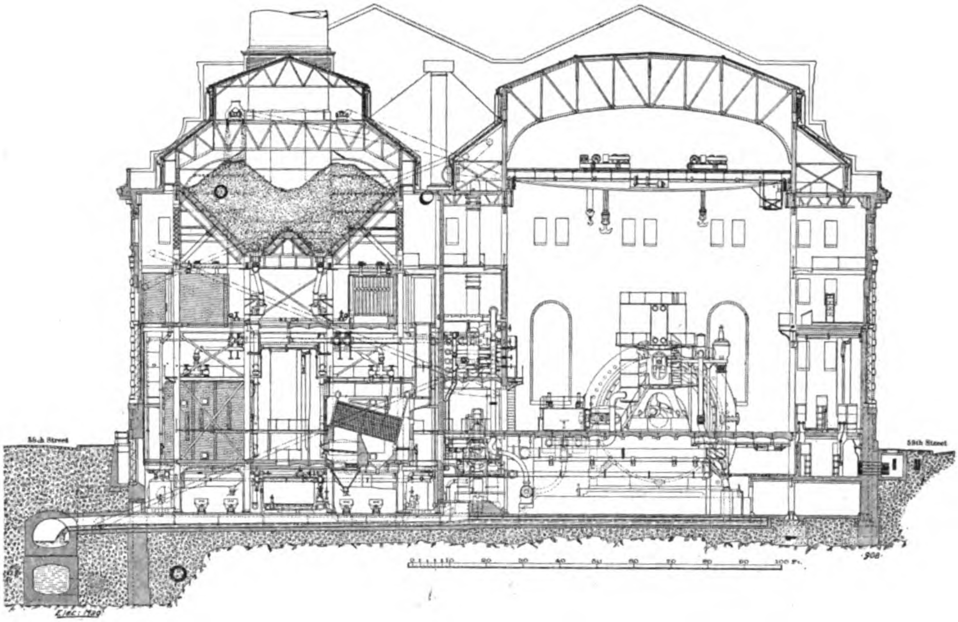
New York Subway Power House.

THE energy for operating the 800 trains, to run in New York's new subway, is furnished from a monster power house which, until the completion of the Lot's Road plant, will be the largest steam operated plant in the world, and then it will only equal the latter plant. We give a plan and end section through the station, from which its huge proportions can be gathered. The boilers in two storeys and four rows are seventy-two in number, surmounted by huge coal "pockets," holding together about 12,000 tons of coal level full, or 16,000 tons heaped. Elaborate coal- and ash-handling plant is, as might be expected, installed. Between boiler and engine-room is an ample steam-pipe gallery, balanced on the opposite side by the switchboard galleries.

There are nine large generating units with engines by Allis Chalmers and Westinghouse revolving field alternators, each such combination yielding 5,000 kw. at 11,000 volts, 25 cycles. The engines have cylinders in quadrature, distinct compound engines operating on each side of a central generator. This type is now well known in America, and in common use coupled to large railway generators. In the same station between the sixth and eighth units, the exciters and four turbo generators are installed, the latter being each of 1,250-kw. capacity. It will be a matter of engineering interest, the operation, side by side, of reciprocating engines and turbines, on so large a scale. Some surprise may be expressed at the adoption of these monster reciprocating engines in so large a power house, and for such a purpose, but it must not be forgotten that this station was designed at a time when data now available on steam turbines were not then procurable. Moreover, American engineers have had an experience of these very large reciprocating sets which has doubtless been marked with economical working and which has fostered a confidence in a machine which probably, in their opinion, can give a turbine points and beat it.



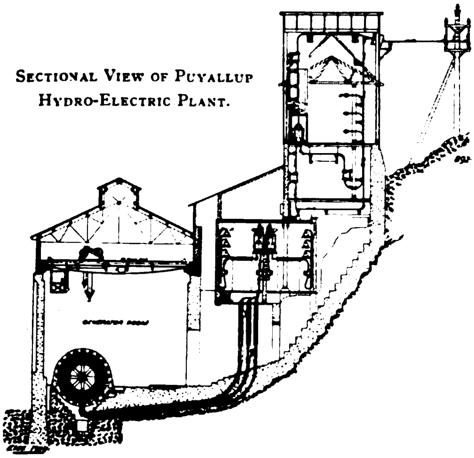
PLAN OF SUBWAY POWER HOUSE.



END SECTION OF SUBWAY POWER HOUSE.

Largest Power Plant on Pacific Coast.

WHAT has proved to be the largest power-plant yet erected on the Pacific Coast has recently been started on the Puyallup River, Washington, U.S.A. Its ultimate capacity will be 40,000 h.p., the initial installation utilising half this amount. The chief American electrical journals have devoted much space to this plant, but the best description brought to our notice is that of the *Journal of Electricity, Power, and Gas* (San Francisco), and to this we must refer our readers for fuller details. The installation bristles with unique features, among which we may enumerate the following: water drawn from glaciers of Mt. Rainer (14,400 ft.) which together with that supplied in rainy season, furnish constant supply throughout the year, a ten-mile flume, a large reservoir feeding the pipe lines, water wheels operating under a head of 872 ft. and a 55,000-volt transmission line. These briefly sum up the plant. The installation has been made to supply Seattle and Tacoma, forty-eight and thirty-two miles distant respectively, with power for railways, tramways, lighting and heating, &c. Work was commenced on March 1, 1903, and the first of four 5,000-h.p. generators was operating on April 14, 1904, the whole plant being completed on July 13, 1904. The watershed was carefully surveyed, and before settling on the position for the intake to the flume, the supply of water to the river, from glaciers and downfall combined, was considered. A spot was found at the junction of the Mowich River, at which the flow seemed constant all the year round, and an intake was built at this junction. A ten-mile flume of wood conducts the water to the reservoir, which is built directly above the power house and holds ample reserve of water should the supply temporarily fail. An automatic spillway controls the outlet to the forebay, a structure which affords facilities for inspecting the individual pipe lines, without emptying the reservoir. Four pipes, 48 in. diameter of ¼ in. thick steel are carried down an incline of 30° to the power house below. The water wheels are of the Pelton high-pressure type, one on each side of a central generator, the wheels overhanging the two main bearings. We shall refer to the wheel equipment of this station in a future issue. The four main generators supply 2,300 volt three-phase current to step-up transformers, raising the pressure to 55,000 volts. The arrangement of the plant can be seen in the adjoining sectional illustration (p. 476). The staging of the various rooms on an incline in the manner illustrated has, we should think, few imitations any-



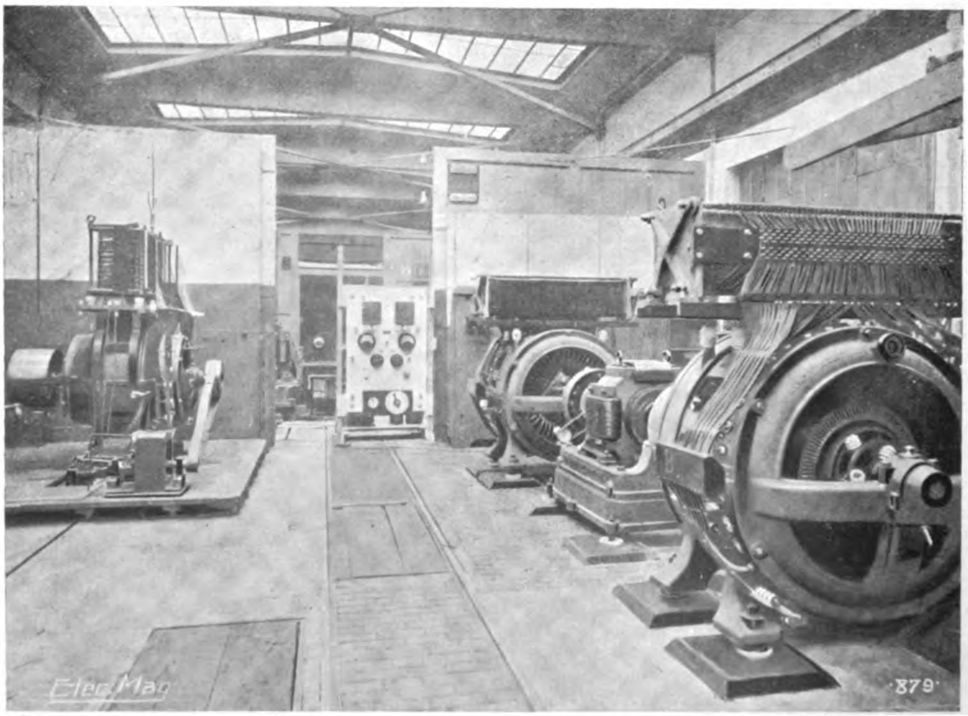
SECTIONAL VIEW OF PUYALLUP HYDRO-ELECTRIC PLANT.

where. The control board is in the generator room, and only the switchgear and instrument transformers are in the upper storeys. The step-up transformers, oil cooled, are on a level with the generators but separated from these by heavy steel partitions. The main buildings are of steel, concrete and brick, the first two predominating. The contractors for the plant, the General Electric Co. and the Pelton Water Wheel Co., are to be congratulated on bringing so important and so great an undertaking into a condition of commercial practicability.

POWER NOTES.

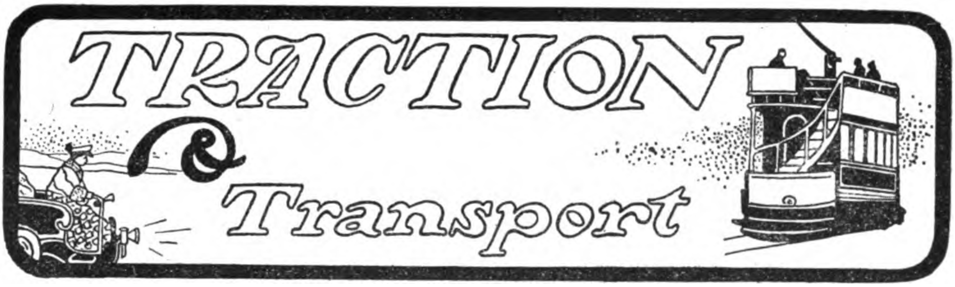
The Ferrara Hydro-electric Plant.

THIS is reputed as one of the most interesting in Italy. Its source of power is a fall of 107 m. available head, obtained by diverting part of the waters of the Margorabbia near Ponte-Nativo. The dam is of very solid construction, to be able to withstand the exceptionally high floods which sometimes occur in these parts. The water-conduit is 530 metres long, 750 mm. in diameter, and from 5 to 8 mm. thick. The turbines, three in number, are of the Pelton horizontal axis type, being regulated automatically by hydraulic gear. At full load the normal consumption is 340 litres of water per second per turbine, with an efficiency of 78 per cent., each turbine contributing about 400 h.p. at 450 revs. per minute. Elastic couplings of the Zodel type connect each turbine to a three-phase alternator of 250 kw. at 6,000 volts and 45 cycle frequency, having an efficiency of 93 per cent. at full load on a feebly inductive circuit. Of the total energy produced, part is used for lighting and motive power in district comprising Luino Varese, Masnago, Comino, and Gavirate, the remainder supplying the local railway line between Varese and Luino.



70,000 VOLT DIRECT-CURRENT TRANSMISSION. VIEW OF GENERATORS USED IN RECENT TRIALS AT GENEVA.

(*See page 334, October issue*)



A classified list of Traction and Transport articles will be found in the World's Electrical Literature section at end of magazine.

ELECTRIC TRACTION FOR RAILWAYS.

VII. The Efficiency of Direct-Current Driving.

By W. M. MORDEY, M.Inst.C.E., Vice-Pres.I.E.E.

(*Continued from page* 43.)

ALTHOUGH it is now getting to be realised that the direct-current system is not suitable for long railways, it is generally supposed that for short busy lines in towns or suburbs—so far as economy of energy is concerned—it leaves very little to be desired.

It may be worth while to examine some of the evidence on this subject obtained from practical working. Of course there are more important things than efficiency—reliability and regularity of working, for example—and on these the direct-current system stands well. Safety of the public is another, but that this quality cannot be claimed for this system will be evident from the number of deaths which have occurred during the few months that the latest additions to the electric railways of this country have been working. It may be asked how it is that the new railways have been so fatal, while the old ones on the same system, such as The City and South London, The Liverpool Overhead, and the Central London Railways, have been working so long without getting a reputation for being dangerous. The answer is that the older lines are protected lines not easily accessible to the public, while the new ones are open on the surface like ordinary railways and more or less easily accessible to everybody. The result has been a rude awakening to those who have believed that there could be no serious danger about a pressure of a few hundred volts, direct current.

In the present article it is proposed to examine the claim often made for this system that at least it is economical so far as the consumption of energy is concerned. In doing so it is necessary to bear in mind that the difference between one system and another in this respect (all other things being equal) may be quite enough to pay a respectable dividend on the undertaking.

Liverpool Overhead Railway

In a previous article * reference was made to the Liverpool Overhead Railway as illustrating the very serious waste of electric energy that may occur with the ordinary direct-current system under the conditions of traffic that exist on a short

* THE ELECTRICAL MAGAZINE, vol. i. No. 3, p. 266, March 1904.

busy town line. It was stated that of the energy supplied to the train 50 per cent. was wasted in heating the brake blocks and wheels, and only 25 per cent. was actually spent in driving the train, the remaining 25 per cent. being wasted in heating motors and resistances. The author takes this opportunity of answering a question that he has been asked several times—on what he based this opinion. But in doing so, he wishes to repeat that he is not to be taken as adversely criticising the working of the Liverpool line which, indeed, possesses some admirable qualities, and is, in some important engineering matters, ahead of any other electric railway.

The Liverpool line is a very interesting one. It has been working since 1893, and was the second electric railway made—the first one was the City and South London, the original tube line started in 1890, both were running years before any of the American railways were driven by electricity.

On such a line as the Liverpool Overhead Electric Railway—it is 6½ miles long, its seventeen stations averaging 620 yards apart—it will be evident that even a moderately high average speed can only be attained by getting up speed very quickly, and by stopping quickly—that is, by rapid acceleration and retardation. Recently a great improvement has been made at Liverpool in these respects, the time for the whole journey being reduced from 32 to 20.4 minutes, the average speed being increased from 12½ to 19 miles an hour, the intermediate stops being 11 seconds each.

Mr. Cottrell, the Engineer to the Railway, some time ago published a very interesting account of the tests of the first of the improved trains* which consisted of two motor coaches and one trailer, and was fitted with four motors each of 100 h.p. The train had a carrying capacity of 154 passengers and when fully loaded weighed 56 tons. The tests seem, however, to have been made with a total weight of 46.3 tons. The results attained during a series of runs are shown graphically by Fig. 1. Fig. 2 gives the results of tests of the motors, which were manufactured to Mr. Cottrell's specification by Messrs. Dick, Kerr, and Co., the efficiency being in the neighbourhood of 90 per cent. throughout the range, covered by the test, namely, from 40 h.p. to 200 h.p.

Fig. 1 will repay careful study. It will be seen that the acceleration at two or three seconds after starting reaches the high value of over 4 ft. per second per second, corresponding with a consumption of 600 amperes at 400 volts (note the drop of E.M.F. from 550 volts as a consequence of this "maximum demand"). Then the usual great waves in the acceleration and current occur in the next ten seconds, consequent on the series-parallel method of control, the acceleration dropping to 0.3 ft. per second per second, and the current to about 260 amperes. Both rise again and then gradually fall till 53 seconds from the start, when the speed, which is still rising, has reached about 31.5 miles an hour. The current is then switched off and the brakes applied, bringing the train to a stop in about thirteen seconds. The

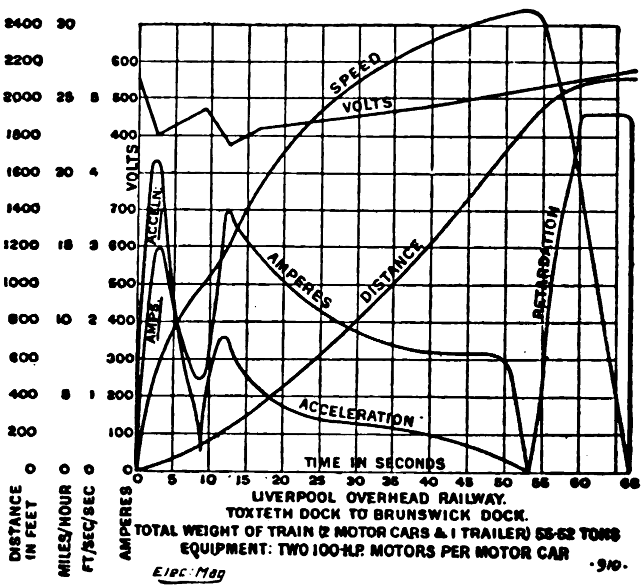


FIG. 1.

* Proc. Institution of Civil Engineers, vol. xlix.

retardation reaches 4.8 ft. per second per second in this severe braking period, during which the train, which has taken 53 seconds to get up speed (having travelled 1,900 ft. in that time), is brought to rest in about 200 ft. This magnificent result in acceleration and retardation has probably never been excelled.

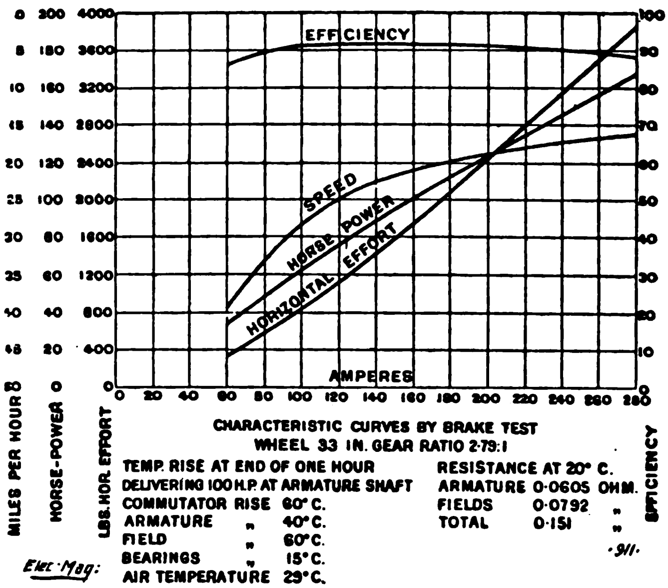


Fig. 2.

But when the other side of the account is examined and the total run considered it will be found that the cost in energy is very great, and that of the total energy used only a very small part is actually spent in propelling the train. If the curves of current and E.M.F. are analysed, it will be found that the energy delivered to the train was 9,400 kilowatt-seconds or 2.61 units.

Now if the traction co-efficient be taken as 15 lbs. to the ton, as an average (it can hardly be more), the energy usefully spent in driving the train over the whole distance of 2,110 ft. will be found to be 0.55 unit—thus the overall locomotive efficiency for the complete journey $= \frac{0.55}{2.61}$, or 21 per cent.

It may be objected that this is not a fair or reasonable way to state the result—that a great deal of the energy must necessarily be put into the train as kinetic energy in getting up its speed; that such energy is properly and economically expended during that acceleration period, and that the overall locomotive efficiency should be judged not on the total run but on that part of it during which energy was being received by the motors.

This objection is a plausible one. It may be supported by showing that the kinetic energy necessary to get a train weighing 46.3 tons up to a speed of 31.5 miles an hour, or 46.2 ft. per second, is 3,450,000 ft. lbs., or 1.3 unit, thus

$$\frac{46.3 \times 2240 \times 46.2^2}{2 \times 32.2} = 3{,}450{,}000 \text{ ft. lbs.}$$

$$\frac{3450000 \times 0.746}{33000 \times 60} = 1.3 \text{ unit,}$$

and it may be urged that as the motors cease work when that speed is reached, the overall efficiency $= \frac{1.3}{2.61}$ or 50 per cent., instead of $\frac{0.55}{2.61}$, or 21 per cent.

It may further be plausibly argued that if train friction be added, viz. 0.55, to the inevitable 1.3 unit, the overall locomotive efficiency should be expressed thus:

$$\frac{\text{Energy spent on driving train}}{\text{Energy given to train}} = \frac{1.85}{2.61},$$

or

71 per cent.,

leaving only 29 per cent. to be accounted for as loss in motors, in starting and controlling resistances, &c.

It may be said that, all things considered, this is not a very bad result.

This is true, up to the point of cutting off the current. But the argument is fallacious; it does not recognise that the real problem is to drive the train the whole distance with the least practicable loss of energy; it does not recognise that almost the whole of the energy stored in the train at the moment of switching off the current is wasted in the brake blocks and wheels in bringing the train to rest. This waste can best be realised by considering what would happen if the brakes were not

applied when the current was cut off—then, instead of coming to a stop in 200 ft., the train would run 4.950 ft. or .935 mile, by its own acquired momentum, before it used up the 1.3 unit stored in it.

Of the rest of the energy, the C^2R loss in the resistance of the motors (given in Fig. 2), accounts for .29 unit, leaving 0.47 unit for other losses.

To sum up, the energy account may be stated thus:

	Units.	Per cent.
Useful work in driving train	0.55	21
Loss in braking	1.30	50
Loss in motor resistance C^2R	0.29	11
Loss in starting resistances and other losses (by difference)	0.47	18
	2.61	100

The principal lesson to be learnt from this is one which the author has repeatedly emphasised during the last three years—that on all short-run lines, instead of using friction brakes, the braking should be by returning energy to the system electrically—making the motors act as generators driven by the energy of the stopping train—what Mr. J. S. Raworth is now urging on the attention of tramway engineers under the name of regenerative control.

Of the other losses it is not necessary to say much—their importance is probably sufficiently realised. The starting losses are large in power rather than in energy—they are large because a very large current at high volts is used, whereas a large current at low volts would do just as well. Those losses are commercially serious, because of their effect on the size and cost of the generating station and of the conductors—rather than because of their effect on the units consumed. They are probably accepted as an unavoidable consequence of using a constant pressure system and the series-parallel method of control; whether they are unavoidable may be questioned.

As we are not concerned in this article with anything beyond the train, we must not go into the question of the transmission losses—they are indicated by the drop of line volts already referred to and well shown by Fig. 1.

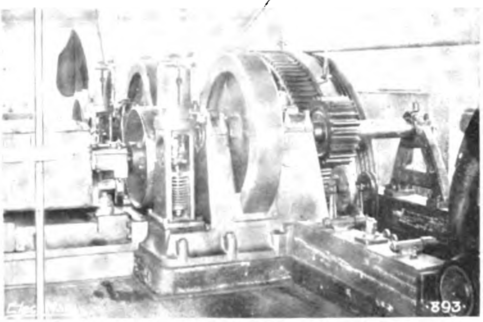
It may, however, be useful to compare the results obtained from the tests with the working results of the railway. We have seen that Fig. 1 shows a consumption of 2.61 units for 2,110 ft. of run, with an efficiency of 21 per cent.; this is equivalent to 6.5 units per train-mile, of which 1.375 unit may be considered as usefully spent, 3.25 units wasted in brakes, and the rest—about 1.9 unit—lost in resistances, &c., on the train.

From the published working results of the railway it appears that for the last six months of 1903, the consumption was 6.09 unit per train-mile, or rather better than would be expected from the tests we have been studying. Possibly the average weight of the trains has been less than 46.3 tons, but in any case there is good cause for congratulating those responsible on the regular working results being better than test results. It is only to be regretted that the efficiency, examined in detail, is not better; but, as already stated, this is the fault of the method of working.

(*To be concluded.*)

Mt. Beacon Incline Electric Railway.

Mt. Beacon-on-the-Hudson, near Fishkill Landing and Matteawan, N.Y., is now mounted by the aid of the Mt. Beacon Incline Railway, one of the steepest inclines in the world. This electric road is owned and operated by the Mt. Beacon-on-the-Hudson Association. The length of the line is 2,200 ft. and the vertical height is 1,200 ft. while the average grade is 64 per cent. The cars operate at a speed of 500 ft. per minute with a load of 10,000 lbs. The road was built by the Mohawk Contracting Co. and the machinery by the Otis Elevator Co. under the direction of the chief engineer Thos. F. Brown. The steel cable used on this incline railway weighs 7,000 lbs., and measures $1\frac{3}{8}$ in. in diameter, its capacity being 124,000 lbs. There are two motors, each of 75 h.p., operating at a speed of 500 r.p.m. Current is received from the power line at 500 volts, being supplied from the station of the Citizens Railway Co. about 6,000 ft. distant. The two cars are each 33 ft. long and 7 ft. 6 in. in width, and are supplied with nine benches having a total seating capacity for fifty-four persons. These cars were constructed by the Ramapo Iron Works of Hillburn, N.Y. The cars are equipped with electric signals placing them in communication with the engine house as well as with each other at all times, and the apparatus is governed by the Otis electric control. The track construction of



HAULING GEAR USED FOR INCLINE.

this incline railway consists of 6 in. by 10 in. stringers on mud sills averaging 6 in. centres, the ties being 6 in. by 6 in. yellow pine, and the safety guard rails 6 in. by 8 in. yellow pine. The line is single track with turn out, the whole track being thoroughly ballasted with rock.

The cars are equipped with the Otis double grip safety device capable of holding 50,000 lbs., and this device is automatically operated by a centrifugal governor which operates the safety should an excessive speed be attained from any cause whatever. The safety is also provided with a hand-operating device by means of which it can be operated by the conductor on the car at any time. A safety device is also provided on the main winding drum, which will also stop the machinery in case of necessity. This is operated by a centrifugal governor, and can also be operated at will by the operator in the power house. In addition to the above, the incline is provided with the Otis electric limit stops, which are so arranged that the cars stop automatically and gradually at the upper and lower stations entirely independent of the driver. The cars are provided with powerful head lights and are lighted with incandescent lamps, while the entire track is also illuminated.

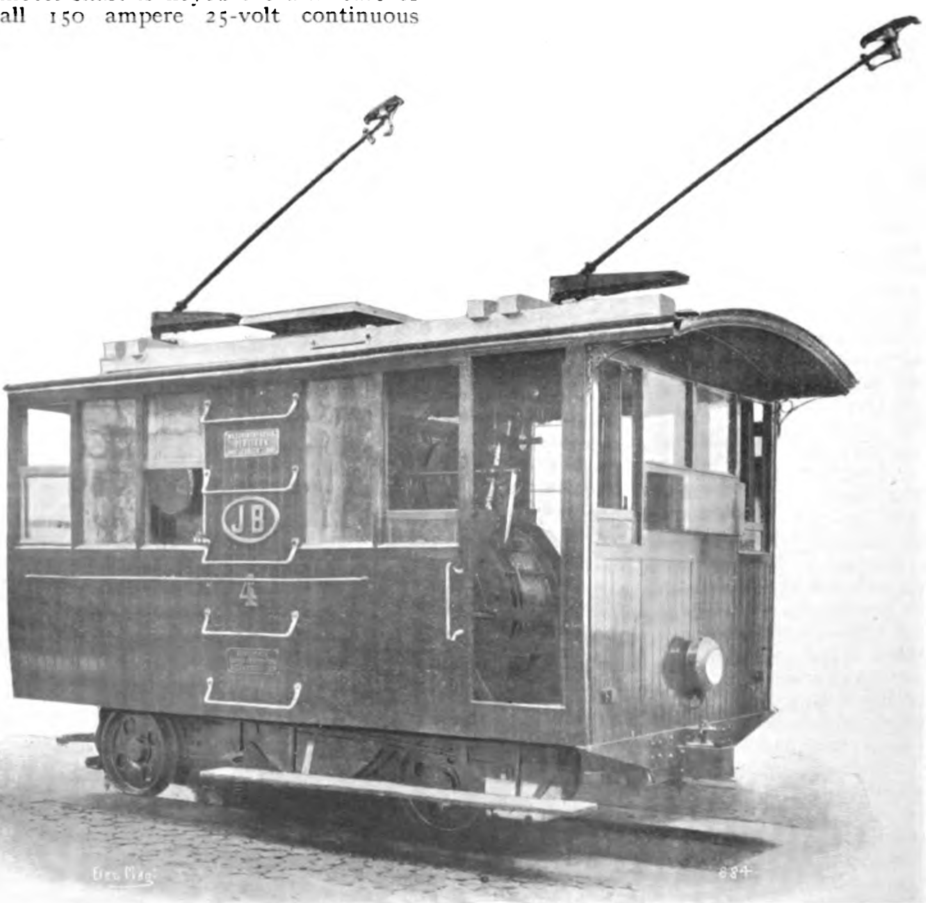
The cars are rigidly attached to ends of the steel cable which is driven by the 8-ft. winding drum, after passing around an 8-ft. idler, also within the power house and at a distance of about 12 ft. from the driving drum. One of the wheels of the cars has a double flange straddling the rail and thus serving as a traction guide, while the wheel at the other end of the axle has a flat face, in order that the wheels of the cars may pass over the cable at the ends of the turn-out; and, in addition to this, emergency guides are provided consisting of steel projections from the car trucks. These projections pass over the guard rail on either side of the track without touching, and thus they decrease the chance of derailment.

By means of the magnetic control system, in case the current is cut off or becomes too low to operate the machinery, or if there is an overload, either the underload or overload circuit breakers are opened and the electric brakes are automatically applied to the cable driving machinery. In case the electric brakes fail to operate, the mechanical brakes will be applied automatically by the centrifugal governor, the excessive speed setting the brakes and stopping the cars. The speed of the car is not changed by the operator, who simply moves the controller for starting or stopping, and, as the car nears the station, a number of limit switches are opened and the current is thus gradually cut off as the car reaches the landing. The current passing through the circuit breaker starts the machinery, and is conducted through various circuits which control a series of magnetic accelerating switches. When these switches are operated the machinery is gradually accelerated and the cars are brought to full speed, the action being entirely automatic, and not being under the control of the operator. In stopping, the limit switches at the side of the track govern the operation of the magnetic accelerating switches, and the car is gradually brought to rest without the usual manipulation of the controller in ordinary railway practice.

INCLINE RAILWAY, SHOWING CARS.

JUNGFRAU RAILWAY LOCOMOTIVES.

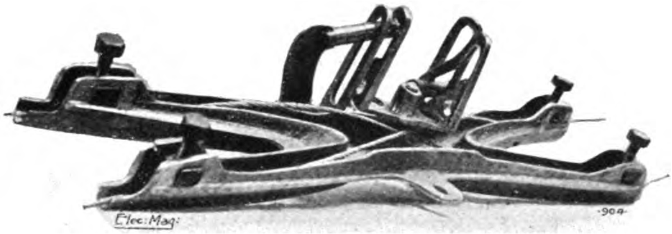
In our September issue we gave particulars of locomotives 1, 2, and 6, in actual operation on the Jungfrau Railway. A few additional words may be devoted to the electrical equipment of locomotive No. 4, built by the Oerlikon Co. of Zurich, which has some interesting points, the mechanical features being similar to those in the engines already described. This engine is driven by two 6-pole triphase motors, each of which develops 120 h.p. in normal conditions at 450 to 550 volts pressure and a speed of 75 r.p.m., the frequency being 38 cycles p.s. The no-load current and losses are 25 amperes and 4,200 watts, while the short circuit current is 800 amperes. Under a load of 120 h.p., the efficiency, power-factor and slip are respectively 92, 90, and 1.5 per cent. The drive is transmitted through worm and spur gearing which has a total velocity ratio of 12.66, allowing a speed of 7.7 km. per hour. On the front motor shaft is keyed the armature of a small 150 ampere 25-volt continuous current dynamo, which is used during the descending journey for supplying current to two of the phases of the motors, thus turning them into tri-phase generators. This provides an efficient and continuous braking action. The ordinary trolley collector is quite unable to cope with the heavy currents required for these powerful mountain engines, and special sliding blocks were designed to meet this difficulty, with contact surfaces made of aluminium. The secondary windings present some novel features, there being separate and independent resistances for each wire terminating at the slip-rings, including the earthed wire. This avoids the complicated arrangements which would otherwise be necessary for regulating the phase of the induced currents when working in parallel. The total weight of the locomotive is 13.4 tons. During the trials it was coupled to a train weighing 27.6 tons, which it hauled over gradients varying from 9.5 to 24.1 per cent. at a farily constant speed of 7.7 km. per hour, the current varying from 60 to 110 amperes.

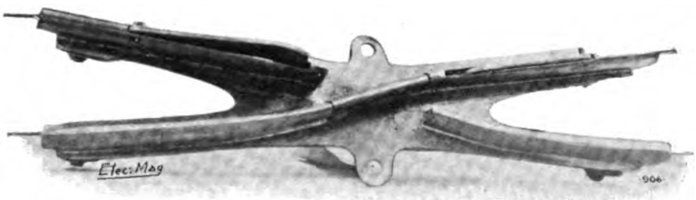


JUNGFRAU LOCOMOTIVE NO. 4.

A NEW CROSS-OVER FOR TROLLEY LINES.

An improved frog or plate for making connection between the ends of line-wires at junctions or cross-overs or any place where the line is not continuous in conductors used in overhead wiring for electric tramcars and the like vehicles, has just been brought out by Thomas Perkins and Sons, Burton-on-Trent. The action is as follows: When a trolley approaches the crossing it raises a pivoted lever which is bent upwards at the inner end through the base-plate of frog and terminates in a small roller which can be seen in the illustrations. Parallel guides are provided to ensure a vertical action of the levers, and the rollers operate a triangular slotted cam, carried at either end of a small turntable. This turntable has a pivot passing through the base plate and carries a short length of swinging rail on the under side of the plate. Thus the upward movement of the lever is transmitted through the cam and turntable, which in turning swings the centre rail into position to complete the path for the trolley to traverse. The cam is provided with a slot at its upper end, to allow for varying or worn trolleys to properly operate the mechanism. A similar but shorter slot is also provided, which allows the roller end of the lever not in use to fall down and effectually lock the swinging rail until a trolley approaches in the opposite direction, when a similar action takes place and the swinging rail is moved into position for the other line to be used. The apparatus is very simple, and absolutely positive, an upward pressure of one pound being ample to operate the device. We should think there is a wide field for the employment of this apparatus, and commend it to the notice of tramway managers.





Views of the Cross-Over in Different Positions.

STREET RAILWAY WEEK AT ST. LOUIS.

During the week commencing October 10, American Street Railway men displayed unusual activity at the Annual Conventions of the American Street Railway Association, the American Railway Mechanical and Electrical Association, and the Street Railway Accountants Association. The gatherings were held at the Exhibition and their success on this account might be gauged beforehand. We give a list of the papers read before the various associations in the literature section at the end of the magazine. Before the first Society the papers read dealt chiefly with prime movers, two papers being on steam turbines and one on the Diesil Engine. The former were mostly descriptive of current types of turbine with data as to tests applied, that by Mr. J. R. Bibbins being the most exhaustive. His illustrations of typical arrangements of turbines and condensing plant were very well displayed and would be handy for reference Mr. Rice in his paper supplied data of the small horizontal Curtis turbines being developed by the General Electric Co. Economics beyond the dreams of Central Station men were held out for the Diesil Engine by Mr. E. D. Meier, who described the principle of the engine and pointed to three 225-h.p. machines running at the St. Louis Exposition. The paper, though ably prepared, was not particularly convincing, seeing that the first cost of the engine is very high and its arrangement at present somewhat com-

plicated. The remarkable economy obtained —approximately equivalent to ¾ lb. of coal per b.h.p. hour — of course offsets these disadvantages. The remaining paper dealt with the subject of transfers on cars.

The second-named Association discussed in a lively manner subjects more dear to the tramway manager proper. The presidential address dealt chiefly with the Economics of electric over steam lines, for interurban and suburban work. The car barn superintendent and the repair department were served up with an item on the ideal repairing-shop — a building of one storey with many bays arranged in two rows on each side of central tracks. The suggestions offered are worth the consideration of any tramway system contemplating the erection of a repair shop. The eternal subject of wheels could not well be omitted from the programme. The author of the paper here plumped for either the rolled-steel wheel or a steel-tyred wheel. The discussion elicited the belief that steel-tyred wheels were giving, generally, very satisfactory results. The most interesting paper was that on the maintenance and inspection of electrical equipment, and it contained, as the president remarked, matter of a "meaty" character. The author advocated the distribution of technical railroad literature among the employees as likely to produce satisfactory results. Inspection of the cars and equipment should be systematic. Failure was to be avoided as a primary essential, and inspection cost should be balanced against breakdown expenses and loss of traffic. On the Boston Elevated surface lines, trolleys, switches, controllers, and motors were inspected after three days' service. Heavy duty cars were inspected daily. Every month motors were cleaned, and all parts lubricated; controllers were dismantled yearly, and also wires inspected for weak insulation.

MONT BLANC RAILWAY.

THE General Council of the Hte. Savoie, France, has granted a concession for a railway line between Fayet-St.-Gervais and Mont Blanc, and a recent decree of the Ministry of Public Works has ratified this decision. The first section will be undertaken at once, extending as far as Aiguille du Goûter, at 11,700 ft. altitude. When completed and in operation the line will be prolonged to the Mont Blanc. The scheme for this railway has been drawn up by M. Duportal, of the Ponts et Chaussées. The line starts from the Fayet railway station P.L.M. line and follows first a departmental road and vicinal road as far as St. Gervais. It then passes Mount Lachat, whence the whole of the valley of the Arve up to Chamonix

VIEW OF MONT BLANC.

may be viewed, Les Rognes (8,000 ft.) and Tête-Rousse (9,700 ft.), where the region of glaciers and eternal snow is reached, and the line becomes almost vertical up to the terminus, which is the Aiguille du Goûter. The length of this first section will be 12 miles. The adjoining photo affords a good idea of the magnificent scenery which will be viewed from the line.

TRACTION NOTES.

Russian Suspended Electric Line.

THE railway line between Moscow and St. Petersburg having now attained its limits of working capacity, the Russian Railway Ministry has appointed a special committee for examining a new scheme presented by Mr. Montjarljarski, who proposes to connect the two cities by an electric suspended railway, a project of some importance, as the distance to be covered is about 650 km.

Valtellina Line Handed over.

THE famous Valtellina line connecting Lecco, Sondri, Colico, and Chiavenna has been definitely handed over to the Rete Adriatica Company, having been operated now for two years by Messrs. Ganz and Co., of Buda-Pesth, who had constructed the line and undertaken its management to ensure its satisfactory working. The fact that the above railway company have taken the line in hand is an important step towards the application of electric traction to standard gauge railways.

Readers are referred to the World's Electrical Literature Section at end of Magazine for titles of all important articles of the month relating to Lighting and Heating.

Lighting Matters before the Congress:

THE ELECTRICAL EXTRACTION OF NITROGEN FROM THE AIR.

By the ASSOCIATE EDITOR.

THIS problem is one of great importance from the commercial point of view, and it is fully to be expected that the question will be solved within a short time. The present source of nitrates is Chile, whence more than 1,500.000 tons of raw saltpetre are now annually exported. The total amount of the Chilian deposits is of course unknown, but a rough guess might possibly put the amount at 100,000,000 tons. Obviously therefore it is impossible to reckon on a permanent output from this source. By far the largest portion of the saltpetre imported into Europe is used for fertilising purposes, and it is therefore a steady market of almost unlimited extent. Naturally the mind of the electrical man has been turned to the question of extracting the nitrogen from the atmosphere, as a development of the experiments of Priestley and Cavendish, who showed more than 100 years ago that if electric sparks are passed through the atmosphere, the nitrogen and oxygen combine, forming nitric acid. But it is a long step from this laboratory experiment, which has been described in chemistry text-books for more than a century, to the commercial application. Even now, after much experiment on a considerable scale, it cannot be said that the problem is by any means solved, though several persons have done hopeful work. The paper by Mr. J. S. Edstrom before the St. Louis Congress is therefore welcomed as giving a general view of the field, and as showing what has been and is being done. First there was the method of Bradley and Lovejoy, who had two drums, one within the other, armed with platinum points, facing one another, the two drums being connected to direct-current poles, at a difference of potential of from 8,000 to 10,000 volts. On rotating the drums, the arcs were formed and then broken. Kowalski's method consists in exposing the air to an oscillating arc with a pressure of 50,000 volts at very high frequency; but this seems open to obvious objections. The method to which Mr. Edstrom draws particular attention is that due to Professor Birkeland and Mr. S. Eyde of Christiania. This is based on the fact that an arc can be deflected by a magnet. An arc is supposed to be formed between two electrodes, and is then deflected by a magnet till it becomes so long that the arc will sooner leap across the short space intervening between the electrodes than continue along the extended path into which it has been deflected. The long arc is therefore extinguished, and the shorter one is formed, only in its turn to be deflected in the same way as its predecessor. This process can go on at a very rapid rate, and in the apparatus used for the work, some hundreds of arcs are formed per second, and the effect produced is called a disc of arcs, seeing that it produces on the eye the effect of a disc of expanding arcs. This then is the idea on which the method is based, and by which the arc is generated. In the apparatus itself, the air is led in closed chambers through the space where the arcs are formed, and the nitric acid is then passed into towers where it is treated as desired. One oven, which is still working, has taken from 75 kw. to 200 kw. in the disc of arcs between a single pair of electrodes. It takes alternating

current of 50 cycles at 5,000 volts. The efficiency of the earlier experiments with this apparatus was 400 kg. of nitric acid per kilowatt-year, and has now been improved to 900 kg. per kilowatt-year. This is a slight improvement on the Bradley and Lovejoy system, which was said to have an efficiency of about 700 kg. of nitric acid per kilowatt-year, and is considerably better than that of Kowalski. The details of the Birkeland process seem to have been worked out with much care, and it is to be hoped that before long the nitrate industry will have been tamed to the electric yoke either through this or some other process.

Charges for Electrical Energy.

One of the papers round which a good deal of interest centred at the St. Louis Congress was that by Monsieur Etienne de Fodor on the methods of charging for electrical energy. He considers that the ideas involved in present tariffs must be traced to their source in the desire to meet gas competition. In most parts of the world there has always been a difference in the price of gas according as it is supplied for power or lighting purposes. A similar difference is therefore generally noticeable in an electric tariff, which, however, unfortunate from the point of view of the users of electric light is thought to be necessary if any portion of the power field is to be acquired A general decrease in the use of gas for motive purposes seems to be noticeable, and during the last year there was a marked falling off in the consumption of power-gas in Berlin, Munich, and Berne, to take examples almost at random. Even now, calculations appear to show that in Berlin, with electric power supplied at 1.6*d.* per unit, the electric motor is twice as expensive as the gas-motor with gas at 2*s.* 10*d.* per thousand cubic feet. Mere matter of price is not therefore everything; rather on the other hand have subsidiary considerations the controlling voice. Monsieur de Fodor therefore thinks it vain to attempt to continue competition with gas in the matter of price, particularly in regard to power purposes. We should rather rely on the simplicity, cleanliness, and general flexibility of our commodity, and let the matter of price be kept reasonable. With this object in view and aiming at general simplification, he holds that there should be one uniform charge for light and power, in which case probably there would be little loss of custom in the power field, where we already hold our own, not in a matter of price, but in supplying a more serviceable commodity. Similarly, producer-gas, which was thought likely to be a serious rival to coal-gas, makes little or no headway; its competition is found to be insignificant. The discussion of the paper brought forward Mr. Gripper, who thought that the idea of a uniform charge for light and power was possibly right, but that it should be arrived at by lowering prices all round. If the price charged for power were lowered, it might become possible to acquire the whole of the power field, which might, he thought, be made to grow to an almost unlimited extent; and in this case the demand for light would be small in comparison, and lighting current might then be supplied without loss at the same rate. Here the wish would seem to be father to the thought; we do not know that Mr. Gripper has ever proposed to his directors to put this plan in practice. Still Mr. Crompton, who is a hard-headed business man, appeared to agree with Mr. Gripper, and drew attention to the fact that the largest dividends were paid by those who charged at the lowest rates. Still, it is difficult to see how any sort of agreement is to be arrived at unless we can as a preliminary agree on first principles. And when we find that one speaker asserts that the main factor in prime cost is labour, and another asserts that it is interest on capital and wear and tear on plant, it would seem that a point like this must be settled before further discussion is profitable. It is not as if the persons who differed were incapable of expressing an opinion, or had insufficiently studied the question. This becomes evident if we state that one was Mr. Hammond and the other Mr. Arthur Williams of New York.

TRAIN LIGHTING.

This is still one of the open and vexed problems which continually provoke discussion. Colonel Crompton at the St. Louis Convention gave it as his opinion that accumulators should be carried on each car, and exchanged occasionally as required. In this way automatic switches, dynamos, and other conceivable complications could be removed from the train, to the great satisfaction of the supervising engineer. Herr Carl Rodenbourg was in favour of the system in use on some of the Prussian lines, where a Laval turbine is mounted outside the locomotive boiler, and connected to a dynamo through gearing. In this way the speed of the dynamo can be kept fairly steady, and in no way depends on the speed of the train. Still a turbine mounted in this way receives very little attention, and variations of speed are therefore expected. These variations, however, make no difference to the lamps, because any increase of voltage is absorbed by small iron resistances which are placed in series

with the lamps, in the manner familiar to us through the series resistances of the Nernst lamp. With this arrangement a variation of E.M.F. from 56 to 86 volts changed the current taken by a bank of lamps on a train from 8.0 to 8.7 amperes. These resistances therefore steady the light and prevent overrunning. Some difference of opinion was expressed as to the value of the well-known Pintsch system of oil lighting, using oil gas enriched by acetylene. In any case accidents have been traced to its use, but its simplicity is such as to make it a serious factor in the competition. Various other electrical systems were also described at the Congress, but nothing very substantial in the way of progress in this field was reported.

STANDARDS OF LIGHT.

PROFESSOR E. L. NICHOLS, who is a recognised authority on photometric questions, contributed a paper to the discussion of the present state of photometry. He thinks that with careful adjustment and with attention to detail, an acetylene-hydrogen standard might be developed, giving a white light which would be better suited for general photometric work than the present pentane or amyl-acetate standards. But even so, owing to the different colours of many of the lights, which have to be compared, it is doubtful whether purely photometric results can have any real value as indicating the amount of working light emitted by any lamp. Possibly something may be hoped from spectrophotometry, of which little is known; but at present exact methods of comparing the newer types of arc lamps, for instance, may be said to be non-existent. The use of an incandescent solid as a standard has often been proposed, and the unit derived from molten platinum sounds likely to be something definite and ought to be easily reproducible; but so far it has always wrecked on practical difficulties. Other proposed standards have been the Welsbach mantle, the ordinary glow-lamp and the Nernst lamp. But no one of these standards could in the present state of our knowledge be reproduced with any certainty, though either of the electrical standards are capable of possibilities and may lead in the future to something better. The principal difficulty with the Nernst lamp or with the Welsbach mantle would be the satisfactory purification of the rare earths, which is known to be a matter of great difficulty, and it seems hardly likely that these oxides will ever be obtained in a state of absolute purity. But it may well be that absolute chemical purity is not really necessary, though it will be remembered that the late Hefner Alteneck was busily engaged in the latter part of his life in attempting to discover something to replace amyl-acetate in the Hefner lamp, on the ground that amyl-acetate could not be obtained as a pure chemical substance.

POINTS ABOUT ALTERNATING-CURRENT ARC LAMPS.

ASSUMING that we have to deal with an enclosed arc, it should be remembered that it is only possible to have an extremely long life of carbons by using a very low voltage, or by having the smallest possible amount of ventilation. Normally with a 6-ampere lamp the most satisfactory rate of consumption of the carbon is about one-tenth of an inch per hour; therefore if we use 12-inch upper carbons and 7-inch for the lower, they will last about 100 hours. A lamp properly designed and in good order should not show a loss of over 25 watts, though many show a loss as great as 45 watts; and this difference, small as it may appear, becomes serious, when we consider that the extra 10 or 20 watts has to be supplied during the whole of the time the lamp is burning and does no useful work in return. There should be little or no noise in a properly working lamp; at any rate if the lamp is at the ordinary height in the street, the noise should be scarcely audible, and it should require a distinct effort to notice the hum, which, however, of course occurs in all lamps of this type to a greater or less extent. The size of the reflector is a matter of importance, and probably a diameter of about eight or nine inches would meet the case.

IMPREGNATED ARC-LAMP CARBONS.

PROFESSOR A. BLONDEL dealt with this subject before the Congress, and described the results which he has obtained with his new form of electrode. This consists of a positive carbon, which is of a composite nature. The outer layer is of pure carbon; the next is a mixture of carbon with salts of calcium or magnesium; and the inner core is a similar one, only differing in that it is less strongly compressed. The results obtained with these electrodes as compared with other forms are shown by the following table:

Kind of arc.	Watts.	Mean hemispherical candle-power.
Ordinary open arc between carbons	495	700
Enclosed arc between carbons	768	329
Steinmetz's magnetite arc	385	400
Bremer arc, inclined carbons (nine amperes)	495	4,814
Blondel carbons (nine amperes)	500	4,800

In the discussion it was pointed out by Professor E. L. Nichols that owing to selective radiation, results obtained by ordinary photometric methods are apt to be misleading, and that with the newer forms of arc

that are now coming into favour something more conclusive than the photometric bench, as at present known, is needed. Dr. Steinmetz also pointed out that high efficiency is not indeed everything; the rate at which the electrodes burn away is a matter of great importance, as is also the steadiness of the arc, the absence of noxious vapour, and other operative conditions. He stated that titanium gives a higher efficiency than any other substance, when used as an arc electrode; it requires only 0.15 watt per c.p.; but this is far from saying that it is suited for everyday requirements. Indeed unless mixed with other substances, it is altogether unsuitable.

STREET LIGHTING BY NERNST LAMPS.

MR. H. N. POTTER read a paper before the St. Louis Congress on the Nernst lamp, and travelled over much familiar ground, describing the whole thing from start to finish. In the discussion that followed, most of the speakers addressed themselves to the lamp in actual working. Mr. Hammond drew attention to the fact, which he has already mentioned on other occasions, that he considered the lamps a failure at Hackney; but in common fairness it ought to be allowed that he was a pioneer, that he had some of the earliest lamps that were made, and that as he did not at first succeed, he omitted to try again. Mr. Terven said that it was very necessary to adjust the filaments when they were once in position in the lamp standard; allowance for expansion ought to be made, and if a lamp lasted over the first fifteen hours, it ought to burn at least 1,200 hours. Other speakers said their experience had been wholly favourable, though Mr. Williams of New York thought that single filament lamps were a failure for street work. On the other hand three-filament lamps and those with six filaments were giving every satisfaction, and were competing successfully for popular favour against even oil lamps.

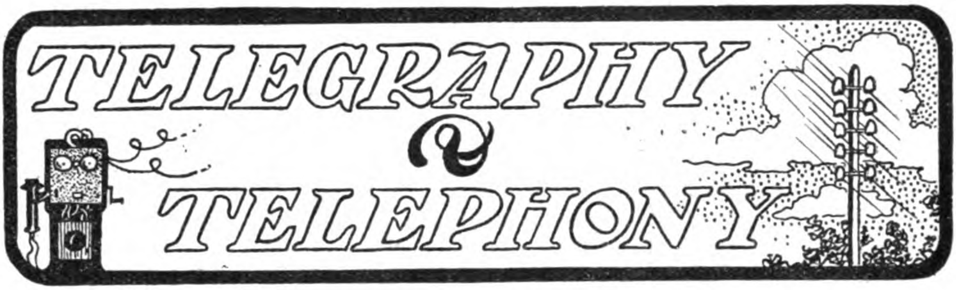
A STUDY OF THE ELECTRIC ARC.

DR. C. P. STEINMETZ has made further communications at St. Louis as to the questions of the electric arc, which he has studied at Schenectady on behalf of the General Electric Company of America. The magnetite arc, which we described in one of our recent issues, is an outcome of his researches, and he considers that the typical open arc is that between iron and copper, or between their oxides. In the magnetite arc, it will be remembered that the current is passed from an electrode of copper, which is so proportioned that it does not burn away, or become seriously hot, while the other electrode of magnetite, which is one of the iron oxides, burns away and gives its character to the arc light. Carbon electrodes have probably been generally used owing to the volatile nature of the carbon oxides, moreover carbon is the only substance of which electrodes can be formed which are capable of maintaining an alternating current arc of low potential. The typical vacuum arc is the mercury arc, which is well known to act as a rectifier under certain conditions. Dr. Steinmetz states that an alternating pressure of 9,000 volts is required if a true alternating current arc stream is to be passed through mercury vapour; if the pressure applied is lower than this, a rectifying effect is produced owing to the high resistance at one of the electrodes, which is only broken down under the high pressure.

MANCHESTER STREET LIGHTING.

A RECENT report published by Mr S. L. Pearce, City Electrical Engineer, Manchester, on street lighting with new Arc Lamps is alive with points which we commend to the consideration of our gas friends. The recent Editorial in the *Electrician* sums up the situation well, and we reproduce our contemporary's remarks herewith.

" If proof were wanting of the superiority of electricity over gas for street lighting, then no better could be found than in the report which has been compiled by Mr. S. L. Pearce, chief electrical engineer to the City of Manchester. It is shown that, for a degree of illumination equivalent to 1,000 c.p. lasting 4,000 hours, the cost of "intensified" gas-lighting, calculated on a basis of 1.08*d*. per 1,000-c.p. hours, which includes 10 per cent. for depreciation, is £18. Under the same conditions, and including carbons, retrimming and 10 per cent. depreciation, with electrical energy at 0.95*d*. per unit, the cost of electric lighting works out at only £12 12*s*. 6*d*. From actual measurements taken Mr. Pearce finds that the cost per mean candle-foot per hour for the arc lamps is 0.28*d*., whereas that for intensified gas-lamps is 0.395*d*. Now, these tests can in no sense be regarded as mere laboratory experiments, since they were carried out under ordinary working conditions by practical engineers, and with an instrument the accuracy of which is beyond doubt. They are not the result of the cogitations of untrained persons who juggle with imaginary statistics and finally evolve a comparison which is striking only by reason of its grotesqueness. Many such comparisons have, of late, emanated from those interested in the gas industry, but they have lacked the hall-mark of authenticity and have, therefore, been very properly ignored.



For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section at end of Magazine.

Telegraphy at the Congress.

While it cannot be said that much that is novel has been presented to the Congress in regard to telegraphy, the opportunity has offered means for reviewing the achievements of the past few years, of effecting a wide survey of future possibilities, and of affording comparisons which may serve as important aids to progress and to the refinement of existing methods. The huge printing telegraph is one that is occupying the minds of telegraphists in America, in England, and in Germany, and the speeds attained over moderately long lines, coupled with the convenient legibility of the record, have served to show that such apparatus will be an indispensable part of the equipment of all large telegraph-offices in a few years' time, for use in heavily worked circuits. We therefore refer at length to the important paper presented by Mr. J. C. Barclay, Assistant General Manager of the Western Union Telegraph Company, which deals with Murray's, Rowland's, and Buckingham's systems, and offers useful indications by which improvements may be effected in transmission. Mr. Barclay remarks as follows:

"Machine telegraphy is undoubtedly destined to play, if not a dominant, at least a highly conspicuous part in the telegraphy of the future. For the present, and probably for a long time to come, the Morse system will continue to be the standard system employed in this country. It is doubtful, indeed, if the Morse apparatus—representing, as it does, the very acme of simplicity—will ever be wholly superseded, but new and improved, as well as more economical methods of working, will, slowly, perhaps, but nevertheless, surely, limit its field of operations.

"The advances made in recent years in the direction of developing and perfecting a printing-telegraph system, adapted to meet all the requirements of a modern telegraph service, have been of such a practical and progressive character as to leave no room for doubt that the successful advent of such systems into the domain of commercial telegraphy will soon be, if it is not indeed already, an accomplished fact.

"Ever since the birth of telegraphy, the subject of printing-telegraph systems has more or less engaged the serious attention of electrical inventors, and, as a result of their efforts, quite a number of such systems have been devised and put into operation; but until quite recently their usefulness has, with few exceptions, been restricted to stock and market reporting or other enterprises of a more or less private and local character.

"For the general telegraphic work of the country these systems are entirely too slow; they can only be successfully operated over limited distances, and their records are, as a rule, made upon a strip of paper which is regarded with anything but favour by the telegraphing public of to-day.

"One principal source of weakness in connection with moderately fast short-distance machines consists in the character of the signalling currents employed, which, as a rule, lack the necessary quality for overcoming the retarding and attenuating effects of the main line. Very short signalling impulses that differ greatly in strength with occasional changes in direction—as employed by some inventors—is not a current arrangement adapted to long-distance transmission. Nor is a combination of electrical impulses of one polarity and of uniform strength much better calculated to increase the

signalling distance over lines of considerable inductive capacity, the tendency of which is to retard and absorb such impulses.

"A much better plan to secure effective signalling is to incorporate into the system a method of reversing or alternating the line currents, and until inventors more fully realise the importance of some such arrangement their chances for success in the direction of long-distance working will be highly problematical.

"The superiority of the alternating-current method for printing telegraph purposes has already been pretty well demonstrated, and this fact opens up the interesting question as to what particular extent such currents might be utilised with advantage in the working of ordinary telegraph circuits. It is well understood that the successful operation of these circuits is seriously handicapped by certain line-disturbing elements that are more likely to increase than to diminish in magnitude and intensity as the years roll by.

"The leakage interference from the ubiquitous trolley lines constitutes, for instance, one of the growing evils that beset the telegraph engineer, while more or less trouble is to be apprehended from the development and extension of high-pressure transmission lines with their immense capacity for creating inductive or other disquieting influences. It is possible to exclude the former, and to modify the effects of the latter's interference by the use of condensers directly inserted in the main line, which arrangement would also wholly or partly rid the circuit of all ground currents and leakage currents from neighbouring wires, as well as minimise the deleterious results arising from defective insulation, variations of resistance, capacity, &c. Such an arrangement, however, would be utterly impracticable with the ordinary battery currents, but, as the alternating signalling impulses can be easily transmitted through condensers, a combination of the character mentioned would seem to lend itself in a manner quite feasible to the practical exclusion of most of the disturbing influences to which all telegraph lines are more or less subjected.

"Whether or not this principle will ever find a general application in ordinary telegraph working, it is certain that the subject is receiving considerable attention at the hands of telegraph inventors, several of whom have already succeeded in making practical applications of such a character as to suggest possibilities of the utmost importance in this new and promising field of telegraphic development.

"The most highly developed specimens and best-known examples of the modern class of machine are those invented by Murray, Rowland, and Buckingham."

The Murray system was described in our issue of January last. We propose later to treat of the other two. Mr. Barclay considers that the use of the perforated tape in the Murray apparatus, at both the transmitting and receiving stations, introduces an element of delay that is more or less objectionable, despite the rapidity of transmission. However, the Murray system is still under trial in the British Post Office and will probably be retained, and between Berlin and Emden it has so far been very successful, more so, we understand, than the Rowland system. Here the transmitting apparatus has been designed to work directly into the line, and to operate the receiving mechanism in a manner equally direct. Direct transmission and reception is, in fact, one of the most desirable features in connection with the operation of any telegraph system, but when this is accompanied by a very large increase in the carrying capacity of the wire over which such system is worked the latter may not unjustly be regarded as one coming well within the range of being an ideal method of working. Such, at least, are the views expressed by the advocates of Professor Rowland's "octuplex system," and these views might be readily accepted if to the other admirable features of this "telegraphic wonder of the age" the great merit of simplicity could only be added.

That the Rowland machine has been very highly developed on the most modern and approved scientific principles is undoubtedly true, but it remains to be more fully demonstrated that an extremely complex system, necessitating the maintenance of the most perfect synchronism, and employing as many impulses as those required for the formation of each of the letters or characters, is one practically adapted to the working of other than circuits of moderate length. Mr. Barclay thinks that to Mr. C. L. Buckingham belongs the credit of having invented the first really rapid, long-distance, page-printing mechanism that was ever successfully employed for the transaction of ordinary telegraph business. Many years had been spent by the inventor in an endeavour to devise and perfect a printing-telegraph machine that could be operated over practically unlimited distances, but it was not until the happy idea was conceived of utilising the Wheatstone Automatic System as a basis that success appeared in sight. Through this means it at once became possible to transmit and receive the necessary signalling pulses over the longest telegraph lines, the pulses in this case differing from

those of Wheatstone or Morse in being quite definite in the number requisite to form the various characters, for each of which six electrical impulses alternating in direction are essential. The Buckingham system has been in practical operation over the Western Union lines between New York and Chicago and New York and Buffalo for the last six years, and has a maximum working capacity of about 200 messages per hour when working duplex. It does not utilise the transmitting properties of a wire to the same extent as that theoretically possible with the Rowland Multiplex system, but it is successful over distances that would not at all be practicable with any synchronous multiplex system as yet invented. It is, perhaps, a disadvantage that a prepared strip must be used for transmitting a message, but the received record is a direct one. One other defect of the Buckingham system consists in the fact that the number of characters that can be printed by means of the type-wheel is limited to thirty-two, admitting only of the letters of the alphabet and certain punctuation marks being recorded. To print all of the characters desirable for commercial telegraph purposes would involve some radical changes in the apparatus, and greatly increase the already complicated character of the system. The author has set out to substitute a modified form of electrical typewriter for the present recording arrangement, and has, by such a device, reached a speed of one hundred words per minute, which apparatus would remove the difficulty above alluded to. He anticipates that the technical and industrial development of the printing-telegraph art will be rapid.

An account of simultaneous Telegraphy and Telephony in Hungary was given by Mr. Joseph Hollas. The practice is becoming an established one and is proving decidedly economical. In the United States and in Germany trunk telephone lines are extensively utilised for telegraphic circuits. The difficulties encountered were well set forth by Mr. Hollas, and the precise mode in which the telephone is connected is thus explained. Instead of joining the circuit first to a repeating coil, the latter is so constructed as to serve at the same time as the clearing-out signal. This is, as a rule, connected in the bridge between the two branches of the circuit, and its duty is by its great self-induction to prevent the wasting of any considerable part of the speaking current. How far it is able to satisfy this demand might be readily ascertained by inserting a receiver in the shunt path. In spite of thus increasing the impedance of the bridge we still obtain intelligible speaking even with a clearing-out signal of 2,000 ohms resistance, if the latter is entirely embedded in iron. These currents do not so rigidly follow the rules which apply to strong currents, and, therefore, inferences drawn from such rules do not apply in this case, as may be shown by a simple experiment. With such a clearing-out indicator 30 per cent. of the energy is lost on the average, and 70 per cent. only is available, With a well-constructed repeating coil, if arranged as a clearing-out signal, the loss is not greater. Consequently, if we insert such a repeating coil into the connecting cord, simultaneous working without affecting the telephone is secured. The repeating coil transformed into a clearing-out drop naturally possesses a closed iron circuit. In European practice this plan is avoided and an open-circuit repeating coil is generally preferred. The question whether the repeating coil has an open or closed magnetic circuit does not affect the high frequency involved, and for weak currents this is of much less importance than the other losses that arise in an open-circuit repeating coil.

For relatively strong signalling currents the closed iron circuit is of decided advantage, because with open-circuit repeating coils it is only exceptionally possible to ring through with alternating current, while it is always certain when there is a closed iron circuit. From the point of view of simultaneous working it only remains to separate the ringing currents. This may be accomplished if alternators are used by branching the ringing current at each operator's position on a separate repeating coil. Where batteries are used, which are to-day exceptional, each operator's position must be given its separate battery.

This system does not appear to differ essentially from the usual Van Rysselberghe system. The author pointed out that, for the satisfactory use of any simultaneous system, it is necessary to lay down very complete rules in order that neither the telegraph nor the telephone service may suffer in operation by their combined use. Mr. Hesketh said that in Australia a ground circuit and not a complete metallic circuit is used for simultaneous telegraphy and telephony. A system also in use in Australia is where two telephone circuits are operated over three metallic conductors. Major Reber said that in the army the grounded circuit for simultaneous telephony and telegraphy had been used with success. Mr. Gherardi called attention to the fact that such a system is also employed on some railroads.

Two systems of "Rapid Telegraphy" were described at the Congress. One by Mr. P. B. Delany makes use of the static capacity of a line to produce the signals.

The definition of dots and dashes when transmitted at very high speed is destroyed, the effect of the capacity being to run them together. A perforated tape is used in the transmitting instrument, and is caused to pass under two contact fingers which respectively make battery contacts through the perforations. A positive current from the station of origin causes an iron electrode to make a mark on moistened chemically prepared tape, and the mark is continued by retardation until a negative current causes the electrode to leave the tape. The primary impulses, whether for a dot or a dash, are all of equal duration, and it is the interval between the positive and negative impulses that determines the length of the mark on the paper. The system is so designed as to carry 1,000 words per minute over 1,000 miles of line.

The second Rapid Telegraph was that of Prof. Ferdinando Lori of Padua, whose harmonic system had, it was stated, given very favourable results on experiment.

In the discussion Mr. Hesketh said that in the Post-office service in Great Britain, in 1888, the maximum speed was 600 words, and that if it is now only 400 words, as stated by Mr. Delany, the service has deteriorated ; and that an average working speed would not be satisfactory if it were not over 200 words per minute. He expressed the opinion that by far the greater part of telegraphic business must be received by sound, transmitted possibly by a keyboard transmitter of the kind Mr. Delany has indicated ; but that to deal with unavoidable congestion of business, he looks forward to the adoption of such a system as that outlined in the paper.

We are not aware that the average speed of the Wheatstone's system in England is so high as 400 words per minute. At the same time there is probably no system in actual use which can at present show a higher figure. Interesting details were given of new dangers to lead-covered cables by Mr. John Hesketh of Australia and Mr. Wotton, whose experience was in the Southern States, both of whom had discovered insects which bore fine holes through the lead.

The paper on "Electrolysis on Underground Conductors," by Prof. G. F. Sever, treated the matter exhaustively and with reference to the results of electrolytic surveys. The discussion which followed brought out some surprising facts associated with the nature of soil concerned, insulated joints, the absence or otherwise of return feeders to the power stations, and of the character of the bonding of the tracks. Currents have been noticed flowing from ground to telegraph lines with an electromotive force as high as seventy-five volts. Grounded telegraph circuits therefore might be the cause of some damage from electrolysis. It is, it appears, no unusual thing for several hundreds of amperes to be found flowing in the lead sheathing of telephone cables in New York, and there is possibility of considerable damage to the lead if another contiguous path diverts part of the current. Professor Sever stated that the sheaths of some undergound cables were bonded to the elevated structure by copper wire, and that fifteen hundred amperes passed through the wire. In this plan lies a remedy for detrimental action to the lead sheath, although heavy return feeders, as well as secure bonding of trucks had also been beneficial in reducing electrolysis. One speaker, indeed, giving the experience of the Postal Telegraph Company, whose underground cables near electric railways had been seriously corroded, stated that by securing a good return wire from the points at which the currents were leaving the cable sheaths, back to the railway generator, the underground system was rendered entirely immune, and that no trouble had since been observed. As a matter of fact, the company loans the sheaths of their cables to the railway to get the current back to the station. Mr. J. S. Edstrom, of Sweden, said there had been very little trouble in Europe from electrolysis, which he assigned to the very solid construction there, both with respect to bonding and cable-carrying return current to the power station. In Berlin no more than two volts difference of potential is allowed between two points on the rails in the city system, and this rule has been adopted in most German cities, and in Switzerland and Sweden. In the latter country there are two heavy copper wires at each joint, and the rails are bonded between each other, and also the double tracks at certain intervals. At bridges, or in passing over water piping, the rails are insulated with asphalt as much as possible. The rails in the street are generally insulated by means of a layer of concrete under them. The return feeders are generally of the same dimensions as the outgoing feeders.

The Cerebotani Auto-Telegraph.

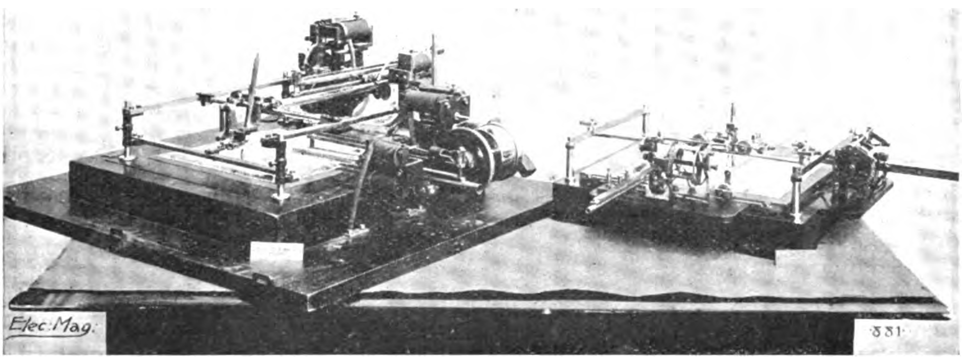
By L. RAMAKERS.

PROFESSOR CEREBOTANI, of Munich (Germany), has just tested with complete success, on several important German and Italian telegraph services, a very interesting apparatus for transmitting writing by telegraph. This invention is the fruit of long-continued researches which induced Professor Cerebotani to construct

his first apparatus; this required three conductors, but he subsequently improved the arrangement to such an extent that one wire only was needed. In view of the results obtained the inventor is credited with the intention of applying his system to the "wireless transmission" of drawings, &c. The Cerebotani apparatus may also be used as a printing telegraph; in this case it would, clearly, afford enormous advantages in comparison with the Hughes apparatus, which, as everybody knows, can only be operated by means of a wire.

The electro-magnetic arrangement comprises four coils of two windings each, and they cross each other upon a board or base-plate. An enormous quantity of two-way variable currents, producing corresponding electro-magnetic effects, may be generated according as to whether the

position in relation to the cross-bars, whilst there is not one single point on the writing-table (however big it may be) that cannot be reached by the small point or stylus intersecting the two cross-bars. Any movement of the vertical tube causes the movement of each of the two points fixed to the cross-bars; this motion must be transmitted to the receiver where it determines the different positions of the writing-tube. The receiver and the transmitter being identical, the result is that there is an analysis and synthesis of the writing at the former and the latter respectively. The transmission of the movement is effected by means of a racked bar fixed to one of the points; the mechanism required to transmit the movement of each point to the receiver consists of a pinion, a wheel, a switch, and a commutator, to which latter



CEREBOTANI AUTO-TELEGRAPH APPARATUS.

currents passed into these coils are more or less intense, or of equal or contrary direction. The almost unlimited variety and number of these current impulses is the most important point worthy of mention, the receiving apparatus being perfectly analogous in its arrangement. The transmitter is formed by two rails upon which there slides a transverse bar, bisecting at right angles another bar placed lower down and sliding also on its ends over two rails arranged perpendicularly in relation to the first two, but placed lower down. At the point of intersection of these latter there are fixed two parallel bats forming a carriage and moving freely between cylinders or rollers, whilst a very easily movable slide is located on each of the cross-bars. These two slides are connected together by a small tube in such a way that, when the latter is moved, it always retains its perpendicular

two batteries are connected by two × and – conductors. The wheel is influenced first by one, then by the other, circuit according to the direction in which the point is moved.

For instance, if it is moved to the right, the negative will be cut out and the positive placed into circuit, the contrary being the case when it is moved to the left. The current leaving the transmitter reaches the receiver through the commutator, and is at one time positive and at the other negative. The position of the points at the receiver is determined by these very current impulses, to which end the points of the receiver are provided with a double racked bar system, in the middle of which there is a pinion rotating always in one direction and rising or falling at the same time in such a way that, when it engages with the racked bar that is lowest, the point moves in one direction (of course carrying

the whole system along with it) whilst, if it engages the upper racked bar, the point will move inversely.

The point at which the alternately positive and negative currents pass abuts on an electro that overcomes the stress exerted by two springs, successively attracting and releasing the anchor of an escapement, thus permitting the forward movement by one tooth of a cog-wheel. This movement results in causing the whole racked-bar system to move forward in one direction or the other, according as to whether the pinion of the escapement-wheel engages the upper or lower racked bar. As the transmitter and the receiver are of identical construction it will be easily understood that, when the transmitter wheel and the number of current interruptions produced there correspond to the number of teeth of the escapement-wheel of the receiver, the points of this latter will follow exactly the movement of those of the former. The current afterwards passes to a second electro, which is polarised, that is, consequently only responsive to a positive current. When it is operated it attracts an armature carrying the pinion, so that this latter alternately engages the upper and lower racked bar (the former when the current is positive). The raised pinion is retained by a pawl, until it is released by the action of a third electro, also polarised, but responsive to the negative current, with a view to avoiding the effect that too frequent interruptions of the current would have upon the pinion. In the preceding arrangement, therefore, two conductors are necessary—*i.e.*, one for each point; the following arrangement, as will be seen, needs only one conductor.

To this end a contact and the parts dependent thereon are closed on a local battery, in the circuit of which there is an electro. A two-armed lever closes the circuit of a second local battery when one of the points is moved, and they are placed in circuit by means of the two electros. The movement of the point in the opposite direction opens the circuit. The second point is provided with an identical arrangement. When the contact mentioned above has been established the electro attracts its armature, and the line battery, whose positive is earthed, is connected by the negative with the transmitting conductor that connects the transmitter and the receiver. If the contact is effected consequent upon the movement of the rod or point to the left, the second local battery is placed in circuit at the same time and the two electros dependent thereon attract their armatures, and elements are added to the line battery and to a fourth battery. In this way negative currents pass into the line, when the point is moved to the left, and these currents are of greater tension than those positive currents that preceded them.

The cycle of events is precisely the same with the second point, save and excepting that the line battery depending upon this point has its positive carried to line whilst its negative is earthed; the current which passes into the line is thus positive, and is more or less intense according as to the direction in which the point moves. The line therefore comprises alternately positive and negative, strong and weak, currents. Here there intervene the fourth and fifth batteries arranged like the two line batteries, and working in the manner hereinbefore described. For this purpose the contacts and armatures of the electros mentioned above are provided with two insulated tongues.

The foremost tongue of the second contact is connected to the second line battery, whilst the rear tongue (like that of the first armature) is connected to a lead; finally the foremost tongues of the armatures are connected to the line, and the rear tongue of the second armature is connected to a sixth battery. The rear tongue of the first contact is connected to a wire running from a supplementary electro communicating with the fourth and fifth battery, whilst the front tongue is connected to the first line battery.

When the two armatures are simultaneously attracted the two line batteries are simultaneously connected to the line by the front tongues; but at the same time, thanks to the rear tongues, an auxiliary circuit is established from the sixth battery, the rear tongues, the supplementary electro and the several wires up to the sixth battery. The supplementary electro is thus energised and attracts its armature. Upon its descent the point of this armature, connected to the line, strikes successively against two contacts connected to the fourth and fifth battery respectively. As these batteries are arranged like the line batteries properly so called, and as they act in the same way in relation to the movements of the points, the currents established, the two armatures spoken of above, are replaced (thanks to the armature of the supplementary electro) by currents of equal value—*i.e.*, of a value corresponding to the direction of the movement of the points, which pass into the line one after the other. The receiver thus obtains currents of different potential and intensity, which determine the operation in a manner similar to that characteristic of the two-wire receiver.

It appears that the Cerebotani arrangement enables a speed of 100 letters per minute to be attained without any difficulty,

but for this a certain skill in manipulation is requisite. This apparatus can be used wherever there is a Morse apparatus, and it may even be connected to a telephone for use in conjunction therewith. The distances over which messages can be transmitted seem to be practically unlimited; even in case difficulties should be met with, these could be obviated by the use of relays.

The Electrical Conditions of the Atmosphere and the Earth

By E. O. WALKER, C.I.E., M.I.E.E.

THE last ten years have, through the patient observations of a small band of scientists, been productive of substantial additions to our knowledge of the actual electrical states of the atmosphere and of the earth under different conditions of time, season, and weather, and a brief review of what has been practically attained, and of what has been theoretically advanced, of late years will be, it is thought, of considerable interest.

As regards the potential gradient, measurements have been made at Luxor, where 128 volts per metre were registered; at Delhi, 127 volts; at Bombay, 64 volts; at Jeur in the Deccan, 150 volts; in Ceylon, 57 volts; at Algiers, 35 volts; on the shores of the Mediterranean, 80 volts; at Freiburg, 100 volts; on Mont Blanc, at an elevation of 4,801 metres, from 600 to 1,000 volts maximum; on the Rothorn, at a height of 2,300 metres, 300 volts; at Paris, in Scotland, 128 volts, and in space, as measured by the use of balloons, at 1,420 metres, 36.5 volts, and at 4,015 metres, 13.4 volts. These figures suffice to show that the potential gradient is less on the sea-coast than for inland places, and higher at considerable elevations on mountains than on the plains. It is acknowledged that the distribution of potential below 1,000 metres is obscure, and liable to considerable and sudden fluctuations, caused by vapour and moist or dry winds. The rising of mist largely increases the potential gradient. On the Rothorn, a change from 300 to 680 volts was noticed from this cause. The direct rays of the sun appear to affect the maximum, which has generally been found to be in the morning between 7 and 11, although on Mont Blanc it was found to occur between 3 and 4 P.M. As showing how potent is the Solar radiation, a fall in the gradient from 150 to 120 volts has been observed during a total eclipse; in other words, by the withdrawal of the direct rays, the air becomes less conductive. But again, sudden rises have been noticed at or about sunset, but these may be attributable to the formation of mist in the air. Although the differences, in point of geographical position of the places of observation, in the potential gradients are so striking, it does not appear, from measurements that have been taken on the earth's surface, that normally any great differences in potential are available between two such places when joined by a wire. From a mountain-top to the sea-coast the effect is more marked than from a place inland at low level to the sea. No difference greater than a few volts has come under the writer's observations on quiet days, and probably, if it be permitted to generalise from measurements taken on lines of five hundred and one thousand miles in length, the difference of potential between one side and the other of the earth, that is, between the hot and the cool side, would not be more than 100 volts. The maxima occur in the morning after sunrise, and again between 9 and 10 A.M. Thus there is similarity, in time of occurrence, to the maximum of potential gradient. Observers are agreed that with increased elevation above the earth's surface the electric potential is in greater magnitude, but in what ratio is not known. If we assume that the values found on mountains and at different points on the earth's surface furnish data for calculation, it would seem that in space the potential must be over a million volts. The destructive effects of lightning have revealed a force of ten times that amount. From an observation made by balloon, as previously stated, the potential gradient in air at a height of 4,000 metres was only 13.4 volts, so that it may reasonably be concluded that at great heights there is no drop until dust or vapour, or both, are intruded by air currents into these regions. Sudden condensation by colder currents may cause a sudden fall and a disruptive effect. One thing is unquestionable, and that is, that below the elevations hitherto dealt with there will always be a disturbed state of affairs, and of which wireless telegraphy must take account. To obtain a serene plane of operation, recourse must be had to immense altitudes. Investigators are disposed to think that, if there were no disturbing factors, the potential gradient would show one simple oscillation in the twenty-four hours, the maximum in the forenoon and the minimum at night. As a fact, within the ordinary regions of observation there is often a double oscillation. For instance, on the Eiffel Tower there is one maximum, and at the Central Meteorological Bureau in Paris there are two maxima.

When a charge is given to an insulated body the conditions of the air in its neighbourhood are modified. The natural tendency is to restore the normal state. For some years past the rate of dispersion has

been observed in many parts of Europe. There is not a concurrence of opinion that there is a direct relation between the rate of dispersion and the potential gradient at one and the same place, but it would appear that there is room for further research before such a relation can be absolutely denied. On the Rothorn they increase together. Some causes which affect the latter also influence the former. Rising mist increases the potential gradient and decreases the dispersion, and wind from the sea, while affecting the former in the same way, appears to increase the dispersion. This latter effect is specially noticeable when the moist south-west wind prevails. In Ceylon it was found, at such times, almost impossible to maintain a charge for a few seconds. At Kremsmünster, with the same wind blowing, the maximum dispersion was forty times higher than during still weather when mist prevailed. The times of occurrence of the maxima are not by any means concordant at different places of observation and are seemingly conditioned by local circumstances, except in regard to rise in temperature, velocity of wind, and in atmospheric pressure, which tend everywhere to create maxima. On mountains the dispersion of negative charges is considerably greater in rate than for positive charges. In cellars and grottoes it has been noticed that positive charges are dissipated the more quickly, and by some this is attributed to the radioactive principle in the soil, the property also of deep springs, and of water drawn from the soil at a depth of one or two metres, and of air blown through water. Sunlight is found to promote negative discharge; rain, on the other hand, aids the dispersion of positive charges. On the earth's surface the radioactive principle is most energetic under a clear sky, and has been found more so in Norway than in Germany, being, in winter, greatest in the evening. Some scientists are inclined to explain the phenomenon of dispersion by the presence of radioactivity everywhere. So far as the atmospheric potential is concerned, a modern view much favoured is that the ultra-violet rays from the sun ionises the air, and the resultant ions are attached to cloud drops, or, conversely, that water vapour condenses on the ions. Another hypothesis is that the sun emits positive and negative electrons. According to each supposition the atmosphere absorbs the positive and the negative go to earth. This process, however, lacks explanation. The number of free ions is said to increase with the purity and transparency of the air and the intensity of solar radiation. The presence of dust, smoke, and great humidity decreases them. Fog and cloud also destroy the mobility of the ions. Hence the decrease in the rate of dispersion of a charge when mist prevails.

Much light will be thrown upon phenomena which are now perplexing when more observations are taken by means of balloons at different altitudes. It is the lack of these which render it difficult to frame a theory which will satisfy the facts which are at present available and which in some senses appear to be contradictory. It is thus to be hoped that the researches of those who have a special faculty for this line of research, as Wilson, Ehert, Rutherford, Elster, Geitel, Simpson, Le Cadet, Pochettino, Lenard, Chanveau, Palmieri, Barus, Egeroff, Gockel, Exmer, Conrad, Saake, Mache, Tufts, and others who have enriched our knowledge of the subject here treated, may conquer the difficulties with which it is invested.

THE TELEGRAPH AND THE TELEPHONE.

In 1903 it is stated there were despatched in the United States telegrams to the number of 91,391,000. Telephone statistics for 1902, published by the Census Bureau, show that the telephone has been developing at an enormous rate of late. This report states that there were something more than 5,000,000,000 telephone messages exchanged in the United States. Thus, although the telegraph is twice as old as the telephone, the latter is used in this country over fifty times as much. Perhaps it is not quite fair to make this comparison, since the fields occupied by the two systems of communication are not entirely similar, nevertheless, while the use of the telephone has been growing rapidly, the telegraph is being used less frequently from year to year. The British Post Office reports that, for the year ending March 31, 1904, 89,997,000 telegrams were passed over its wires, showing a falling off from the previous year of 2.7 per cent. Part of the decline in the use of the telegraph is undoubtedly due to the telephone, but other causes seem to be at work. It was asserted recently in one of our contemporaries that the great industrial combinations which have been formed have cut down enormously the number of telegraphic messages sent. Large business houses have always been good customers of the telegraph companies, and when a number of these companies pass under one control, the messages are reduced accordingly.

In comparing the use of the telegraph with the telephone, it should be borne in mind that while Great Britain leads in telegraphic messages, this country is far ahead in the frequency with which the telephone is used. Nor should it be forgotten that in one telephone conversation two persons

take part, while the telegram represents a message in one direction only, and if it provokes an answer by telegraph, two counts are made.

Still, it may not be safe to assume that the telegraph will be ultimately eclipsed by the telephone. Mr. Delany makes some apt remarks on this point at the St. Louis Congress. They are as follows: Rapid Telegraphy foreshadows great changes in correspondence. Outside of the present telegraph business there is a vast and profitable field for development of an electrical correspondence for which the trains are too slow, and the present telegraph and telephone too expensive and inadequate. The telephone cannot compete with the telegraph for long-distance communication. Its average is not more than sixty intelligible words per minute, or thirty words per wire, which is twenty to thirty words below the present telegraph-wire speed, and only about one-fortieth of the number of words that can be recorded by rapid telegraphy. Long-distance telephony is commercially possible now only through the rental of superimposed Morse telegraph circuits, two of which are obtained from the metallic circuit of the telephone; the difference in the minimum rate of the telegraph and the telephone must always sustain the supremacy of the telegraph for distances of over fifty miles. Forty cents for a ten-word telegram, and five dollars as a minimum for three minutes' talk, New York to Chicago, leaves the telegraph practically without a competitor; and when, by the Rapid System, availment of all that a wire can carry is had, delivering to the customer a type-written letter of 180 words, or the telephone five dollars' worth, for say seventy-five cents, the permanent prevalence of the telegraph as the great medium of communication and correspondence will be indubitably demonstrated; millions of local telephones will collect and distribute telegrams for high-speed work over trunk lines; the post-office will also be used for collection and delivery of telegraphed letters; between cities separated by any considerable distance all correspondence of any urgency will be telegraphed at a cost so moderate that the wire will supplant the train as a mail carrier, and the relation between miles and time will be practically set aside.

DETERMINING THE DEPTH OF THE SEA.

A RECENT issue of *Elektroteknisk Tidsskrift*, Copenhagen, contains a description of an ingenious apparatus invented by a Norwegian engineer, Mr. H. Berggraf. The apparatus is intended for recording the depth of the sea at any moment without there being any material connection between it and the bottom of the sea. The underlying principle consists in measuring the time required by the motion of a sound-wave to and from the bottom of the sea. The greater the depth, the more time will evidently be required, and if experiment had shown, *e.g.*, the sound to necessitate one second for travelling to and from the bottom, in case the latter is at 900 ft. distance from the surface, and if on board the ship there were a sound emitter and an acoustic tube liable to be immersed in the water together with an ordinary clock, the depth could be ascertained with some degree of accuracy. If, for instance, four seconds be noted, the people on the ship would be informed that the bottom of the sea lay at 7.750 ft. distance. Instead of using a dial, it would be more convenient to have the readings of the apparatus recorded on a strip of paper, so as to be able to compare the registered curves with the map of depths, and thus obtain some information as to the place where the ship happens to be. This is ensured by the Berggraf apparatus, which consists of a sender, a receiver, and a time-keeper. A disc, turning slowly round, bears on its periphery a cam, which once every revolution makes contact with another cam, thus completing a circuit and causing the hammer of an electro-magnet to emit a number of sound-waves against the bottom of the sea, whence these are thrown back to the ship and received by a microphone. In the circuit of the microphone is inserted an apparatus designed on the telephone principle, and whose membrane is not acted on by any other sounds than those it is tuned for, in virtue of a resonance tube. If the sound emitted by the electro-magnet hammer have a period corresponding to the sound reinforced by the resonance tube, the membrane will perform strong vibrations which are registered on a band of paper.

Wireless Telegraphy.

WIRELESS AT THE INTERNATIONAL ELECTRICAL CONGRESS.

IN the section devoted to Electrical Communication there were quite a number of papers dealing with wireless telegraphy, some of which are of great interest.

Prof. Stone contributed an interesting paper on the "Theory of Wireless Telegraphy," in which the subject was treated from a mathematical standpoint. He first dealt with the simple, popular means of explaining the development and propagation of the electro-magnetic waves, put forward

by Blondel in 1898, which the present author conveniently termed the "electrical image theory." This theory, it is shown, accounts for the bending (the following by them of the curvature of the earth) of the waves emitted by a grounded oscillator, since, at points where the earth's surface is at an angle to the equatorial plane of the system formed by the oscillator (and its electrical image), the currents induced in the earth tend to bend the wave front at the earth's surface into a position normal to that surface. The theory gives good qualitative explanation of the phenomena, but it is not adapted to give quantitative values which are needed by wireless telegraph engineers, who require information rather as to the currents and potentials in the oscillator than a knowledge of the field produced. Rough results may, however, be predicted by means of the image theory. Thus, with similar transmitting and receiving oscillators of equal radiation and absorption, the energy received should be directly proportional to the fourth power of the lengths of the oscillator, and inversely proportional to the square of the distance separating them—empirically determined by Signor Marconi and termed, as Prof. Stone points out, "Marconi's Law" by Prof. Fleming.

A working theory is then outlined, based upon the theory of the vibrations of mechanical systems, investigated by Lord Rayleigh, and on the Electromagnetic Theory papers of Mr. Oliver Heaviside, several assumptions being made for the purpose of simplifying the analysis. This portion is purely mathematical, but several points of interest to engineers are shown. Thus the distance apart of the two waves as they travel off to infinity is equal to four times the distance from the source to the insulated end of the wire, or if this distance$=\lambda$, then $\lambda=4a$, where a=length of oscillator wire (including image); for the fundamental vibration of the oscillator $\lambda=4a$, as is generally known.

But for oscillations graver than the fundamental of the oscillator the reactance is negative or a capacity reactance, while for higher frequencies the reactance becomes positive or an inductance reactance. Curves are given in the paper which show very clearly the increase of apparent capacity of the oscillator as the frequency is increased, and the tendency to become infinite as the frequency of the oscillations approaches the fundamental of the oscillator. All the important characteristics of a vertical oscillator as indicated by this theory are found to be confirmed by experiment.

In a paper on "Electrolytic Receivers in Wireless Telegraphy," by Dr. L. de Forest, the various wave detectors used as receivers for wireless telegraphy are briefly referred to, chiefly as leading up to the electrolytic types, known, the one as the de Forest-Smythe anti-coherer type, and the other the type at present used by de Forest, but the invention of which is at present attributed to others, although claimed by the author as his own discovery. Dr. de Forest's descriptions of experiments made with this form of detector were followed with the greatest interest, and the experiments themselves, which chiefly dealt with attempts to prove that Prof. Fessenden's assertion that the working was due to a bolometer or heat effect, were absolutely convincing on this point. (Some of the experiments had simultaneously and quite independently been carried out by Messrs. Rothmund and Lessing in Germany, unknown to the present author.) It was proved that the mere coating of the fine electrode with a film of platinum black of almost infinitesimal thinness was sufficient to completely inhibit the effect—a clear proof that it is *not* due to a bolometer working; and the opinion is expressed that the effect is due to polarisation, or rather the annulment of the initial polarisation in the presence of the electrical oscillations. Numerous other experiments are described with which it is impossible to deal here, but owing to their interesting nature, and to the fact that one or two points in the conclusions drawn therefrom seem to be at variance with the weight of experimental evidence, these will be referred to at a later date. The points are: (1) the second type detector is a purely electrolytic device, an opinion which is not, however, shared by Mr. Smythe, the co-inventor; (2) the electrolytic detector (second type) is a potential operated device, and (3) the effect is only obtainable when the small electrode is made the anode.

The various results obtained in long-distance and overland wireless telegraphy are then referred to, and the regularity of the action of the detector commented upon; in this respect it is compared to the magnetic detectors, and the greatest praise for the electrolytic detector is considered to be that as regards regularity it resembles the magnetic forms, though the sensitiveness is stated, but without any evidence whatever, to be very much greater.

In Prof. Fleming's absence his paper on the "Present State of Wireless Telegraphy" was only read in title. The treatment was very much on the lines of, though briefer than, the well-known Cantor Lectures on the subject at the Society of Arts last year. Very little matter that is new was given; the Marconi system, as would be expected, was accorded extended treatment.

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section at end of Magazine.

Electro-Chemistry at the Congress.

THE meetings of this Section were held in co-operation with the American Electro-Chemical Society, the Faraday Society of Great Britain, and the Bunsen Society of Germany. Prof. H. S. Carhart officiated as chairman of the Section and Mr. Carl Hering as Secretary. We have already given a list of papers read and discussed.

Prof. Richards, in the opening paper on "The Relations of the Hypothesis of Compressible Atoms to Electro-Chemistry," stated that it was an observed fact that the volume of a solid chloride or bromide did not equal the sum of the volumes of its constituents, viz. the metal and the liquid chlorine or bromine; and further, that the change in volume varied with the energy of the reaction. From this he was led to conclude that the atom itself is compressible, an hypothesis which is consistent with the modern notion of the corpuscular structure of the atom. If the atom were perfectly elastic, vortex motion and temporary rhythmical distortion would be accounted for by the shock which arises from the combination of an atom with other atoms. Faraday's law of the quantity of electricity transferred admits of an explanation by this hypothesis, in that the shock arising from atomic combination starts or transfers a vortex or some other form of self-perpetuating shock. Weight or mass need not be ascribed to the electron—a permanent vortex will represent the needed unit as well as a ponderable particle. It is only, however, a compressible atom which could hold or carry such an infinitesimal vortex; hence the hypothesis is dependent upon that of compressible atoms.

"The Electrical Extraction of Nitrogen from the Air" was next given by J. S. Edstrom, and we comment upon this in the Lighting and Heating Section.

"The Chemistry of Electro-Plating" formed the subject of the next paper presented by Prof. Bancroft, who endeavoured to locate the causes leading to bad deposits. The conclusions reached, however, were combated in the ensuing debate, particularly by Mr. Betts, who was of opinion that Prof. Bancroft's generalisations were based on insufficient experimental evidence. He further objected to Professor Bancroft's statement that a fine-grained deposit is favoured by high-current density, having himself found that it was favoured rather by a low-current density.

The paper on the "Carbon Cell" was read in the absence of the authors by Prof. Burgess. It is an important communication and throws considerable light on the action of the Jacques cell, which consists of carbon and iron in an electrolyte of fused sodium hydrate. Hitherto it has been supposed that the E.M.F. has been the result of a thermo-electric action, the iron being the hot junction and the carbon, cooled by the air, the cold one. The explanation offered by the authors is that the battery acts as an oxygen-hydrogen gas-cell, differing, however, from the Grove gas-cell in that it is not liquid water, but a solution of water in fused sodium hydrate which is produced by its action. The iron electrode is rendered "passive" by the formation of a layer of iron oxide, in which state it represents an oxygen electrode on which atmospheric oxygen acts similarly as on a platinised platinum electrode dipped into an aqueous conducting solution. This action of the oxygen is brought about by the presence of sodium manganate, which is present in such quantities in fused commercial sodium hydrate that its presence can be chemically determined. In the discussion, Mr. C. J. Reed expressed his disbelief in the existence

of a continual layer of iron oxide, nor did he find a sufficient explanation of the effect attributed to the presence of manganese.

The paper on "The Electro-Chemical Series of Metals" dealt with the researches carried out by the author, the outcome of which was that he was led to conclude that, regarding the difference of potential between a metal and an electrolyte, not only does the osmotic pressure of the simple ions of the metal in the solution and the electrolytic solution tension of the metal determine the potential difference, but *every* ingredient used in making up the solution affects it.

In his paper on "The Lead Voltameter," the author reviewed the advantages attaching to the use of lead as a substitute for silver or copper in voltameter work. The most important are stated to be: (1) That the lead deposit, unlike that of silver, is smooth, dense, coherent, and non-crystalline; (2) That it is well adapted for obtaining electro-chemical efficiencies of experiments requiring long duration; (3) That, as compared with silver, lead stands very high in the E.M.F. series; and (4) That it is cheap to construct.

Mr Jas. Swinburne was not present to read his paper on "Chlorine in Metallurgy," which describes a new process of reduction by the use of chlorine employed at the Castner-Kellner Co.'s Works. Chlorine has been used in metallurgy before for attacking metallic gold; and salt has been employed for "chloridising" roasting. The present process is, however, a new departure, of quite a different kind, and is really a new form of metallurgy calculated to displace the oxidation and reduction processes now in use to a great extent How far the replacement will take place depends eventually on economy only. The principle of the process is treating sulphide ores, without previous roasting with chlorine, so as to form chlorides of the metals, the sulphur being liberated as such. The chlorides are then electrolysed, yielding metals and recovering the chlorine. The chlorine thus goes round and round; and the process in its simplest form is analogous to separating the sulphur from the metals electrically, and changing the ore, at the mere expense of electrical energy, into its component metals and sulphur. In practice there are further modifications. The process naturally gives the best commercial return on ores that are refractory to other treatment; and complex ores yield mixtures of chlorides and gangue which could not be electrolysed straight off without intermediate treatment. The intermediate treatment is always simple chemically, and consists in removing the gangue and substituting zinc for the other metals one after the other till there is nothing left but chloride of zinc. This chloride of zinc is then electrolysed and the zinc and the chlorine recovered. If there was no zinc in the ore, all the zinc obtained is used up again; but if there was zinc in the ore it is sold as zinc. The history of the process dates from 1897, when it was tried in the laboratory and afterwards on a pound scale. A works was taken in Milton where a 3,000-ampere electrolytic vat was run continuously for three months. Facilities were wanting there. The Castner-Kellner Co. have since put down an experimental plant and have acquired a licence for making chloride of zinc.

Dr. Goldschmidt's paper does not call for particular notice here beyond mentioning that he dealt with the now well-known method of welding and repairing castings by the use of "Thermit," which is a combustible mixture of aluminium and iron oxide.

An important paper, bearing as it does on the standard of E.M.F., was that of Professors Carhart and Hulett, dealing with the materials used in the construction of standard cells. The subject has been dealt with earlier in the year by the same authorities,* but the present contribution is much more complete.

It is the Hg_2SO_4 used as a depolariser that causes the variation in the E.M.F. of the Clark cell, which, as is well known, has a high E.M.F. when first set up, but settles down to a constant value only after the lapse of some weeks. In their investigations the authors found that preparations of well-known makes of Hg_2SO_4 differed by as much as 0.001 volts from the standard sample which was electrolytically prepared. Dealing with the hydrolysis of Hg_2SO_4, an action which must be strictly avoided in standard cells, the results of experiments with concentrated Hg_2SO_4 are given which would prevent hydrolysis

The method suggested of preparing mercurous sulphate is then given in detail, as are also exact instructions on the preparation of the remaining materials and the method of setting up. With regard to the Weston cadmium cell, the E.M.F. with electrolytic mercurous sulphate is given as 1.01907 or 1.01908 at 21.1° C. after equilibrium has been reached. The agreement of the cells themselves as to E.M.F. shows an improvement on the Clark cell.

* *Trans. Am. Elec. Chem. Soc.*, vol. v. 1904.

Electro-Physical Papers before the Congress.

Section A. General Theory.

PERHAPS the most important group of papers read and discussed in this section were those centring on the question of electrical and magnetic units, in which much interest was manifested.

Prof. Ascoli, representing the Italian Electrical Engineers, dealt with "Systems of Electrical Units," and put forward a suggestion that a system based upon units different to the C.G.S. was to be preferred. The 4 π factor in magnetic equations was troublesome, and could be replaced by choosing a proper value for the permeability of air or ether.

Profs. Carhart and Patterson dealt with "The absolute value of the E.M.F. of Clark and Weston cells," pointing out that the results so far obtained showed that the E.M.F. of the Clark cell at 150° C. was nearer 1.433 than 1.434.

Dr. Frank Wolff, in his contribution on the "So-called International Units," reviewed the whole subject, pointing out that no two countries had, strictly speaking, defined electrical units in the same way. The speaker thought this was due to the insufficiency of the Chicago (1893) definitions. In the United States the legalised value of the Clark cell is 1.434 volts at 15° C. He favoured the primary definition of the volt rather than the primary definition of the ampere. In the opinion of the author the Weston cell has the following advantages over those possessed by the Clark, which he thinks will render it certain to displace the Clark type in the laboratory.

The higher temperature coefficient of the Clark cell is a serious obstacle to measurements of higher precision, while that of the Weston cell at ordinary temperatures is less than one-twentieth as great, so that errors due to temperature uncertainties are correspondingly reduced. Clark cells are subject, particularly when a number of years old, to large hysteresis effects attending temperature variations. In the Weston cell the error due to this cause can only amount to a small fraction of that in the Clark cell, owing to the relatively slight influence of temperature on the solubility of the cadmium sulphate. The average life of Clark cells is quite short, owing to the tendency of the cell to crack at the point where the platinum terminal is fused into the amalgam limb. This objection might be obviated by suitable modifications in the construction, as have been suggested, but not without producing some complications. No such tendency has been observed with Weston cells. In Clark cells a layer of gas is formed at the amalgam surface, even when carefully neutralised solutions are employed, which may interrupt the circuit, thus rendering the cell useless. In the Weston cell no gas is, apparently, formed.

Two determinations of the E.M.F. of the Clark cell in absolute measure, made by Kahle, at the Reichsanstalt, and by Carhart and Guthe, indicate that the value adopted by the Chicago Congress, 1.434 volts, is too large by about one millivolt; and in addition several redeterminations of the mechanical equivalent of heat in electric units give values for the latter which can only be brought into accord with the values determined by the direct mechanical methods if the E.M.F. of the Clark cell be taken as 1.433. If this value be adopted for the Clark cell or the equivalent value for the Weston cell, the international units would be defined with a quite sufficient absolute accuracy, as the above value is most probably known to at least one part in 2,000, and as at the present time a much higher absolute accuracy can hardly be predicted.

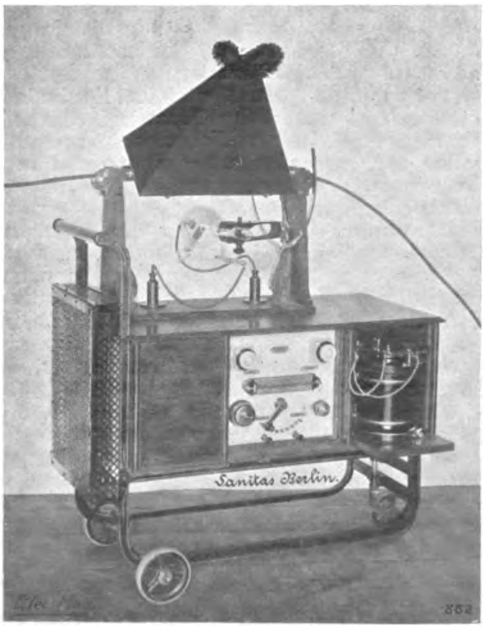
In the discussion which ensued, Dr. Glazebrook admitted the superiority of the Weston cell, but did not advocate making the change from the Clark to the Weston cell now. He also doubted the wisdom of replacing the volt by the ampere in fundamental definition at present, in which he was upheld by Prof. Carhart. Dr. Kennelly made a plea for names for all the units of the C.G.S. system, so that all investigators could talk in it. The argument applied also to magnetic units. Prof. Perry was in favour of basing everything on the C.G.S. system, but did not, however, advocate the multiplication of names.

The paper on "The Mechanical Equivalent of Heat measured by Electrical Means," by Prof. H. T. Barnes, discusses the probable value of the mechanical equivalent of heat in terms of the accepted values of the electrical units.

It is pointed out that the measurements of the equivalent by mechanical methods differ from each other by 1 part in 1,000, but by adopting the latest values obtained for the Clark cell and the ohm, the continuous electrical method agrees with the mean of the mechanical measurements. The author proposes that the value 4.186 joules in terms of the mean unit be selected, and this would appear to accord best with the results obtained by electrical and mechanical means. He deems it advisable to select a thermal unit, which is a mean over the range between 0 and 100° C., and is thus independent of any temperature scale.

X-RAYS AND THE MANUFACTURE OF ELECTRIC CABLES.

THE X-rays have finally left the medical sphere, in which they seemed doomed to remain, to enter the field of industrial applications. The "Sanitas" Society of Berlin has recently designed and constructed an apparatus based on this principle, for use in finding out foreign bodies in the insulating layers of cables. Thanks to this apparatus, one can now ascertain very closely the perfect condition of the cables before laying, and one may easily conceive the great saving in money and time which follows from this system, chiefly for the cable industry. It has happened that either one or other part of the india-rubber of a cable lying in the bottom of the ocean, showed such defective insulation that the cable would soon be totally unfit for use. Nowadays, to detect, in such cases, the localisation of the defect, one is yet obliged to proceed to an expensive exploration of the line, involving the successive lifting up, from the depths, of practically all the cables. As shown in the figure, the arrangement of the "Sanitas" Co.'s apparatus comprises an iron frame, carried on three rollers, and provided with a bundle and a receptacle located on the same frame. This receptacle has one of its lateral walls made to move, and it contains the induction coil and a small distribution board with switch, rheostat, fuses, &c. The control resistances are located behind the board. On the lid of the receptacle there is placed a stand provided with two rollers for the passage of the cables to be examined, and with a wooden gripper for the X-rays globe. At the lower part of the frame there are the terminals connecting the globe to the induction coil by means of two small flexible wires. Finally, the stand is surmounted by a cryptoscope with a luminous screen, which rotates round an horizontal axle, the cable itself passing between the lamp globe and the cryptoscope. Every irregularity in the make of the cable, such as air-bubbles, shivers, &c., is immediately shown upon the transparent screen. The test can be made right away without having to darken the room, as the opaque walls of the cryptoscope deflect all undesirable rays of light from the observer's field of vision. To examine a cable, it must be taken slowly across the screen, and the light of the Rontgen tube shows immediately, to the observer, any dirt or flaw in the insulating layers. As will be seen, the verification thus applied to the make of the cable is of the most exhaustive kind, and does not allow any defect whatsoever to escape detection; moreover, the easiness in removing the apparatus, thanks to its small compass and portability, allows of its rise anywhere. The connection with the high-tension circuit may be effected by means of an incandescent lamp socket as well as with a contact pin.



X-RAY APPARATUS FOR INSPECTING CABLES.

ELECTRO-PHYSICAL NOTES.

Deformation of Tension Curves in Alternators.

BOTH the current and tension curves of any single-phase and rotary-current machine show more or less great departures from the normal sinoidal curve. The advantages and disadvantages of the deformed curve are not the same for any cases obtaining in practice. Pointed curves, on account of the smaller hysteresis loss and magnetisation currents, are more advantageous with transformers, while the higher fall in tension and necessity of a stronger insulation is no doubt a disadvantage. In the case of glow-lamps and motors, the shape of the curve matters little, whereas in the case of arc lamps endeavours have been made some years ago to use pointed curves to high advantage by connecting up in series four lamps with 110 volts. Pointed curves will, however, prove absolutely prejudicial where the higher harmonics result in resonance phenomena. The conditions resulting in a deformation of the tension curves are investigated by Mr. Wangemann in Nos. 36 and 37 of the *Elektrotechnische Zeitschrift*, the following results being arrived at: The electromotive force of an alternator will undergo a deformation at no load: (1) on account of a modification in the speed of the lines of force, the more so as the induction and number of teeth are smaller; (2) on account of alteration in the number of

lines of force, the more so as the number of teeth is smaller and the induction greater: (3) on account of the permeability and remanence, the more so as both factors are greater. The remanence will result in the zero being displaced. In the case of a dynamo yielding current: (1) the current curves will be deformed because of the variable self-induction, and (2) the tension curves on account of the armature reaction; (3) in the outer circuit: (*a*) there being a high self-induction, the current curve will approach to the sine curve, while the tension curve becomes more pointed than the no-load curve, the maximum remaining the same; (*b*) in the case of the circuit including a capacity, the current curve will remain deformed, while the actual value of the tension curve is augmented; (*c*) in the case of a quality of phases, the maximum of tension will remain the same as with no load: (4) hysteresis will result in (*a*) the first half of the current curve and (*b*) the second half of the cycle in the tension curve being broadened according to the value of $\cos \phi$.

On High-Tension Condensers.

In Nos. 25 and 26 of the *Elektrotechnische Zeitschrift*, Prof. J. Moscicki records the results of an extensive series of experiments on high-tension condensers. In the case of the relative losses of apparent energy, $JV = 2\pi f CV^2$, undergone by the condenser being calculated, it is found that with constant frequency and for a given thickness of glass, these losses will augment for increasing tensions. Hence it is inferred that the losses for a given condenser taken absolutely cannot be proportional either to the square of the tension as assumed by Steinmetz or to any other lower power of the tension as stated by Arno and Threlfoll. For the same kind of glass, the relative losses are found to diminish according to a law so far unknown with constant tension, constant frequency but increasing thickness of glass., The losses in glass condensers will accordingly augment for increasing potential falls. With constant tension and given thickness of glass the relative losses will augment for increasing frequency. The total losses in Bohemian glass such as used for testing tubes, with alternate current of fifty periods per sec. and a potential fall of 250,000 volts, are found to be less than 1 per cent. of the apparent energy traversing the condenser. The losses in the glass are found to be due to conduction only to a very small extent (about 2 per cent. of the aggregate), the mean source of losses being deformations undergone by the dielectric for variable fields.

Electrification of an Insulated Metallic Conductor.

The method used by Prof. J. J. Borgmann in some researches on the radio-activity of certain Russian slimes (see *Physikalische Zeitschrift*, No. 17, 1904) was analogous to the one employed by McLennan and Burton in investigating the electric conductivity of atmosphere. Two cylinders were used, one of which (8.3 cm. in diameter 20 cm. in height) was made of brass and the other (22.5 cm. in diameter, 35 cm. in height) of zinc. The former was fitted with a removable bottom, while the other could be opened laterally. Both cylinders contained a brass wire placed axially and insulated from the cylinder by an amber tube, surrounded by a grounded brass ring, the so-called protective ring. The wire of either cylinder could be connected to one pair of quadrants of the same Dolezalek electrometer, the other pair of quadrants being earthed and the needle charged to 100 volts by an accumulator battery. Any portions of the connecting wires projecting from the cylinder were encompassed by earthed protective tubes. Now in the course of the author's investigations on the ionisation of the air within either of the metallic cylinders, the following remarkable phenomenon was noted: after both the metallic cylinder and the wire contained therein had been connected to the ground, the earth connection of the wire was broken, when the electrometer needle would show a deflection lasting for some time, so as to gradually increase. The author ascertained that this phenomenon could not be due either to a possible electrification of the amber-ring to which the wire was fitted or to a thermo-electric effect between the different wires. It was further noted that in the two cylinders, the deflection of the electrometer needle would occur in opposite directions. Whereas in the zinc cylinder the insulated brass wire took a gradually increasing positive charge, an increasing negative charge was noted in the brass cylinder. The charge taken by the insulated wire is thus dependent on the nature of the surrounding cylinder. As the connecting wires were surrounded also by a metal, namely, the grounded brass tube, it was thought probable that these wires alone would show the same phenomenon, this supposition being borne out by experiment. The effect of the cylinder on the wire contained therein and one of the protective tubes on the connecting wire occurring simultaneously, the two processes are superposed in the original experiment. From the results so far obtained by the experimenter, the conclusion is drawn that the phenomenon in the case of the same cylinder is greatly dependent on the degree of ionisation of the air in the cylinder as well as on the condition of the cylinder surface. Provided the effect of the connecting wires be accounted for, it is found that all the metals excepting brass will produce a positive electrification of the wire and accordingly the air. Further experiments will have to ascertain whether or not the positive electrification of the air is due to the alpha rays emitted from the metals.

On Hot Oxide Coherers.

Mr. M. Hornemann two years ago drew attention to the fact that an oxide layer interposed between the parts of a metallic contact touching each other will impart to the latter a singular sensitiveness not only with respect to any current wave traversing the contacts, but as well with respect to electric oscillations acting on the contact from a distance. The contact is caused to effect, under the action of electric waves, mechanical oscillations susceptible of

being heard with a telephone. These researches, published in vol. vii. of the *Annalen der Physik*, were taken up again quite recently, and in vol. xiv. of the same periodical the author records some further experiments where the contact effect with higher temperatures is investigated. While hot oxide layers do not exert any much stronger effects than a cold layer in the case of the contact parts consisting of the same material, a notable increase of the effect was observed in the case of different metals being used. Interesting results were obtained on investigating, by means of a galvanometer needle, the influence of electric radiations on a heated lead-copper coherer (with an interposed oxide layer). This coherer was shown to behave, generally speaking, like an anti-coherer, that is, in a manner analogous to the Schäfer plate, decohering itself spontaneously. Under certain conditions, however, its action will be like that of a Branly tube, which has to be decohered by knocking. In the case of a telephone being used instead of the galvanometer, the sound intensity will increase rapidly and to an extraordinary extent on the contact being heated. This behaviour is not accounted for on the hypothesis of a simple alteration of the resistance, but the E.M.F. of a thermo-current seems to be also operative.

Residual Luminescence of Metallic Vapors in Nitrogen.

IN No. 17 of the *Physikalische Zeitschrift*, Mr. P. Lewis records some spectroscopical observations on the residual luminescence of the metallic vapors in nitrogen, stated by himself as far back as in 1899.

(1) This luminescence is shown to occur only in nitrogen carefully purified from any impurity excepting metallic vapors and possibly NO, while a strong electric discharge is a necessary condition.

(2) The spectrum of the residual luminescence is discontinual, consisting of bands and lines.

(3) Some of these lines are due to mercury and aluminium, whereas some others seem to be unknown bands.

(4) The residual luminescence of metallic vapors accompanies the residual luminescence of nitrogen; its emission will cease instantly together with the discharge, while its presence does not seem to be essential for the residual luminescence.

(5) The aluminium radiation will continue at least during 0.08 sec. after the current has been broken, the mercury radiation being very strong in this interval.

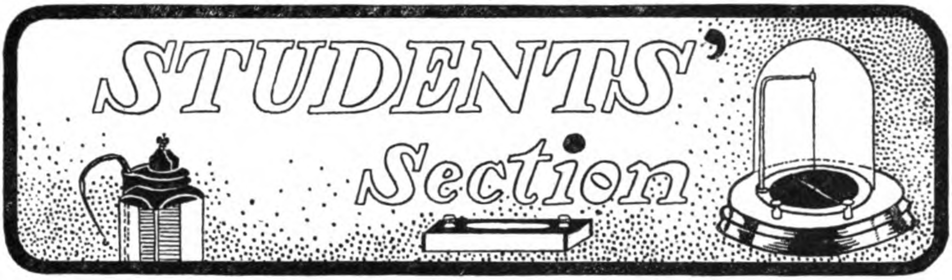
(6) The aluminium line will appear only for relatively high pressures, whereas mercury lines are noted with any pressures, being the strongest line observed in the residual luminescence with very low values of the pressure.

Ionisation of Gases by Röntgen Rays.

MR. R. K. McCLUNG, in the September number of the *Philosophical Magazine*, calls attention to the fact that the various determinations which have been made by different experimenters of the amount of ionisation produced in hydrogen by Röntgen rays differ greatly from one another. Prof. J. J. Thomson had suggested that these discrepancies might be due to rays of varying hardness being employed in making the different determinations. The author's investigations show this to be the case. The method employed was a differential one, the ionisation of hydrogen, the gas which showed the greatest discrepancies being compared with that of air, which showed the least. The pressure of the hydrogen giving the same ionisation as air was 0.116 that of air. The author found that the ratio of the total ionisation in oxygen and in sulphur dioxide to that in air approached the ratio of the densities of the gases more and more nearly as the hardness of fthe rays was increased. In comparing hydrogen and carbon dioxide with air, it was found, on the other hand, that the variation of the ratio of relative ionisation was in the opposite direction. It was found throughout the experiments that there was a general tendency for the ionisation in the denser gas to become more nearly equal to that in the less dense gas as the penetrating power of the rays increased.

Producing High-Frequency Alternate Currents.

IN physical researches, as well as in technical work, high frequency alternate currents are often required; this is the case, for instance, of the verification of self-induction coils. Now the means so far available for generating similar currents were rather complicated, while the machines designed for the purpose did not allow of 10,000 cycles per second being exceeded. Apart from the originality of the idea itself, the following process, due to Mr. Ruhmer, should therefore be of interest. The process embodies an application of the telegraphonic principle suggested by Mr. Poulsen and used in connection with the latter's magnetic phonograph. In this apparatus a series of different magnetisations is produced by means of microphone currents in a steel band or disc. As these magnetisations are permanent they may serve to reproduce in a telephone circuit the currents corresponding to the sound-waves to which were due the microphone currents, so that in the receiver the sound-waves themselves are heard. The apparatus invented by Mr. Ruhmer consists of a steel disc in the neighbourhood of which an electromagnet is placed radially. Before using the machine the disc is polarised throughout its periphery by means of an electromagnet fed with alternate currents of ordinary frequency in a single very slow revolution. An alternation of north and south poles is produced on the periphery, this series being much closer than would be possible in the case of real electromagnets of even the smallest dimensions being ranged side by side. The steel disc will accordingly constitute an inductor, with a series of alternate poles in extremely high numbers, and if it be made to rotate rapidly the electromagnet bobbin used in polarising the disc will give off alternate currents of frequencies up to 50,000 cycles per second, in the case of the electromagnet being designed conveniently.



Students should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles of special interest to them.

On Mutual Instruction among Students.

The work of the Students' Section of the Institution of Electrical Engineers.

By A. G. ELLIS.

It is proposed here to give a brief sketch of the work of the Students' Section of the I.E.E., mainly with regard to what we may call "mutual instruction," in the hope that it may at least prove of interest, and possibly arouse or fan into flame the interest and enthusiasm of students and others for the work of the Section.

The Students' Section is a class of the Institution rapidly growing in importance, and is year by year strengthening its position and work with regard to the Students of the electrical profession. To realise this it is only necessary to glance back and compare the results of the past few sessions with those gone before from about twenty years since.

It is to some extent regrettable that the internal affairs and doings of the Students' Section are not more widely known: being only a students' class some are apt to overlook them and their affairs, and others to pass them by indifferently; but it may be here mentioned that on more than one occasion members, of high standing in the profession, who have kindly presided at Students' meetings, have expressed admiration, not far short of surprise, for the standard of the papers read and the way in which students enter into the discussions.

It must be remembered that from the students of to-day will be drawn the leading and representative members of the profession of to-morrow, forming the foundation of the Institution to which they belong during the next few decades.

For this reason alone they should be encouraged and assisted in any of their efforts for their mutual welfare and unity as a class.

The Institution has for its main object the promotion and advancement of Electrical Science and its applications, and to facilitate the exchange of information and ideas on these subjects. This is, of course, applicable to the Students' Class, which is but a part of the great organisation, and, as it were, a wheel within a wheel: but there is necessarily a difference between the students and the main body of practising members. Students, especially those comparatively new in the electrical field, cannot be expected to keep pace with and take maximum advantage from the sayings and doings of the learned and wise members in their conferences. It is here that the Students' Section demonstrates its utility, for here the student may discuss his problems and difficulties among his fellows in his own way and to his own satisfaction.

Here he may derive benefits to himself by "mutual instruction," which is doubtless the broad principle underlying the work of the Section. Here we have brought into contact all the student types from the "university" to the "premium"—the one who is launching out into the world, and the one who is pushing his way on by hard perseverance and evening-class work. All are able to meet in the unity of their Institution for advancement and interchange of ideas and experiences.

In this educational age it is a good thing to have a centre of meeting for electrical students of all types, undergoing training of all kinds.

The correct system of training has been much discussed of late. No single system can be perfect, but the constant intermingling of all types of students should afford opportunities of helping to obviate the imperfections which are felt most by the students themselves.

In this connection we are pleased to recall the invitation of the President for students to give their views in the discussion on a recent paper on "American Engineering Schools and Education" before the main body of the Institution.

We will now take a look at the constitution of the Students' Section.

The total number of student members is now over one thousand. The business is managed by a representative committee consisting solely of students.

The following colleges are represented: Central Technical College, Finsbury Technical College, Faraday House, King's College, Northampton Institute and University College, and the extra-collegiate students, *i.e.*, those not studying at one of the above, are represented by four members on the Committee. It is worthy of note that among the above-mentioned colleges we have examples of all the present types of engineering education: "solid" college courses of different durations, and "sandwich" systems of different proportions of theory and practice. In addition to this the extra-college members may be fairly representative of the different branches of the industry, and so the Committee is not a one-sided affair. The Committee elect from their number a chairman and hon. secretary at the end of each session, for office during the next. The Section is governed by its own rules, and business is transacted and proposals made and organised by the Committee, subject to the sanction of the Council of the Institution. Thus the class is almost entirely a students' affair in which they go their own way, but, be it remembered, under the experienced advice and guidance of the Institution's Council.

The main business, from the instructional standpoint, falls under the headings of meetings and visits to engineering works.

The meetings are held in the Library of the Institution, 92 Victoria Street, S.W., where a spacious and comfortable room is available for the purpose, on Wednesday evenings at 7.30 P.M. There are generally twelve meetings during the session, the dates of which are arranged before the commencement of the session to alternate with the fortnightly ordinary full meetings of the Institution. After the ordinary business of the meeting either a paper or lecture is read or a discussion takes place on some suitable subject. We may mention here that a departure has been made for the opening meeting of this session on November 16, when Mr. J. Swinburne, Past President, I.E.E., has kindly consented to deliver an opening address. The good that this will do to the students, individually and collectively, can be anticipated, and we may hope it will become an annual and important event. As to the papers read by students, it is appropriate here to remark on the general high standard to which they attain; and it is good evidence to record that of the twelve papers read during last session, four have been printed and published—two in the I.E.E. Journal and two in technical journals of high standing. It is not too much to hope that some arrangement will be found in course of time, whereby most of the students' papers may be printed and published. We can be confident that such an arrangement would meet with approval, especially judging from the opinions of students of to-day. The papers read cover a very wide field and in most cases in a manner very comprehensive, making them to students really valuable and useful: the writer has met many students who would be thankful to have copies of papers they have heard. Lately there has been rather a run on heavy electrical engineering subjects, but the list of suggested subject-matter recently issued by the Council gives a wide range for a thoughtful student, and also serves as a reminder that heavy work is not the only class on which he must fix his attention. This also reminds us by the way that the Council are taking a practical interest in the Students' Section.

The papers, which must be original, are limited to one hour's duration in reading, after which they are discussed by the meeting. It is at this point each student has his individual opportunities, and is able to "find" himself. There is a deal of truth in the saying that the discussion is best—especially when there is a "row" on. It is not improper to say that students should come to a discussion with the deliberate intention of a row; having war in their heart is much better for them than a mere "I thoroughly agree" and "We must all admire" style of discussion. Although we cannot at present supply each student with a copy of the paper, an approach to this is made in the form of an abstract, a copy of which is given to each one present and is obtainable beforehand from the Hon. Secretary. A copy of the paper is placed on the Library table some days before reading, and it is hoped that during the coming session several copies of each paper will be available which may be borrowed by students wishing to discuss. It is a fine practice for a student to discuss these papers, giving him no small experience against the time when he will

be speaking before some higher society. Besides this he finds out what he knows and how he knows it, and gains a confidence in his knowledge by standing up and speaking before his fellow-students. A student should not be afraid of saying what he thinks or what he is convinced of; if he should get "in a hole" he can be assured of not being terrifically "sat on," but rather gently "pulled up": we must not forget we are all in the progressive stage, and he is much better than the one who sits in obscurity, afraid to give his opinion or ask a question for fear of being not quite correct. If all would bear this in mind there might be possibilities of "all night sittings," but what a help to our mutual instruction principle! It should be mentioned that the chairman at students' meetings is generally a full member of high standing, and often a specialist in the subject dealt with by the paper. He usually concludes the discussion, and being in a position to speak authoritatively on the subject, it is needless to say that the chairman's speech is found of great interest and utility. A word as to the writing of papers: Students brought into contact with or having opportunities to investigate special matters of interest, or meeting with things others have not the chance, should make efforts to let their fellows benefit therefrom. A good motto is: "If thou hast knowledge, let others light their candle at it."

It is well known that the Institution award every year at least three valuable premiums for students' papers. This is in itself an attraction, but this should not be the chief object borne in mind—rather aim to present a paper which will be of practical and immediate use to its hearers.

Before each session a series of about twelve visits to works in and near London is arranged. The list is drawn up by the Students' Committee, subject to the kind permission of the various firms included; it is arranged to give students an opportunity of inspecting during the session as large a variety of works as is possible.

The value of such visits need not here be dwelt upon, especially for those yet young in their studies. Suffice it to say these visits are thoroughly appreciated and well attended. Many useful things can be picked up, but it is rather a pity to see so few students using pencil and paper on these occasions. There is surely no harm in jotting down a few notes unless, of course, the firm object to such, which by the way can be easily ascertained, although our friend the British workman may say a few things and possibly think more.

The writer was glad to see the note-book in evidence during the series of visits around Birmingham last Easter. Mentioning this brings up the subject of the Easter Students' tour. For the past few years a week's tour has been organised by the Students' Committee, taking place during the Easter vacation. The following districts have already received visits: Manchester, Newcastle, Leeds, Sheffield, and Birmingham. The tour is becoming an annual event and may in future years go farther afield than our own borders. These visits are not, of course, limited to the London students, but students come from all parts of the British Isles to the centre chosen for visiting.

Apart from the educational value, the visits are excellent social institutions, and there is no doubt that any one who has participated in one will have thoroughly enjoyed and have pleasant recollections of the same. Now that we have Local Students' Sections forming in the large provincial manufacturing towns, the Easter tour should become a convenient centre of meeting for students from all parts. In the last tour to Birmingham forty-two students took part, of whom twenty were from London, and fifteen different works were visited during the week. Detailed accounts of the visits have appeared in the technical papers at the time.

Thus we have briefly sketched out the main work of the I.E.E. Students' Section, chiefly from the point of view of mutual instruction.

The Committee is, however, always ready to take up any matter considered worthy or appropriate to the general ideas of students as a class. As an instance we may remember the gratification and sincerity expressed by the Italians for the Memorial Shield which the Electrical Students of England placed on Volta's Tomb (on the occasion of the Institution's Italian Tour in 1903)—a movement carried out by the I.E.E. Students and their energetic Hon. Secretary at that time.

The Students' Section has been gradually but surely brought up to its present level, and it is hoped settling on a firm basis. To maintain this we must look to each individual student member for a keen and personal activity, the which he should look on as a privilege, a duty and a personal responsibility. It should not be left to an enthusiastic few to maintain the centre of activity, but it is earnestly hoped that all students who read these lines will make special efforts to show a personal and hearty interest during the coming season. They will find their efforts well repaid both educationally and socially, and in addition will give no little satisfaction and gratification to the writer hereof.

Problems on Distributing Networks.—I.

By ALFRED HAY, D.Sc., M.I.E.E.

Ever since the introduction of large electrical distributing systems, the study of the problems which arise in connection with such systems has engaged the attention of electrical engineers. The design of a distributing network on rational lines—as distinguished from the haphazard method in vogue in the early days of electrical distribution—is, indeed, one of the most complicated problems with which the electrical engineer has to deal. Much valuable information on this subject is scattered throughout various technical periodicals, and although the main outlines of it have found their way into the leading text-books, much remains in a form not readily accessible.

In the following series of articles, we propose giving a systematic account of the more important methods for dealing with network problems; and for the sake of completeness, we shall include in our account one or two matters generally to be found in text-books. It will be convenient to consider the subject in the order in which it naturally presented itself in the course of its historical development. The simplest case is that in which the lamps or other current-consuming devices are arranged in parallel between two leads, as shown in Fig. 1. This arrangement was the standard one in the early days of electric lighting, and so long as the number of lamps is not excessive, no inconvenience results from its adoption. Owing to the resistance of the leads, there is a steady fall of potential along them, so that the difference of potential between them steadily decreases as the

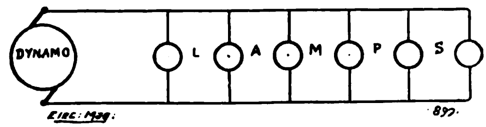


Fig. 1.

distance from the dynamo is increased. Hence the lamps or motors which are at a greater distance from the dynamo are supplied at a lower P.D. than those nearer it. Now the candle-power of a lamp varies at a much more rapid rate than the P.D. across its terminals, a variation of only 1 per cent. in the voltage producing a change of as much as 5 to 7 per cent. in the candle-power of the lamp. For conductors of a given size, therefore, there is a limit to the number of lamps which may be supplied when connected as in Fig. 1, this limit being fixed by the lowest voltage at which it is practicable to supply a lamp.

Algebraical Method of Determining Drop.

We shall now consider how the fall of potential along the main leads may be calculated when the demand for current is accurately known. Since the two mains are of equal cross-section, it will obviously be sufficient to calculate the fall of potential along one of them, and then double the result in order to get the total fall or "drop."

Let in Fig. 2 the straight line AB represent one of the mains, and let currents i_1,

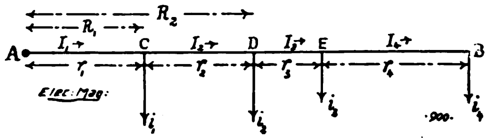


Fig. 2.

i_2, i_3, and i_4 be tapped off at the points C, D, E, and B respectively. Let the resistances of the consecutive sections AC, CD, &c., of the single main be denoted by r_1, r_2, &c., and let I_1, I_2, &c., stand for the currents in the consecutive sections of the main. The dynamo or other source of E.M.F. is supposed to be connected to the point A. It is evident that

$$\left.\begin{aligned} I_4 &= i_4 \\ I_3 &= i_3 + i_4 \\ I_2 &= i_2 + i_3 + i_4 \\ I_1 &= i_1 + i_2 + i_3 + i_4 \end{aligned}\right\} \quad \ldots\ldots (1)$$

The total drop along AB is the drop along AC, plus that along CD, &c.; and since the drop in each section equals the product of the resistance of that section into the current, we have

drop along AB $= r_1 I_1 + r_2 I_2 + r_3 I_3 + r_4 I_4$,

or, using the values of I_1, I_2, &c., given by (1),

drop along AB $= r_1 (i_1 + i_2 + i_3 + i_4) + r_2 (i_2 + i_3 + i_4) + r_3 (i_3 + i_4) + r_4 i_4$.

With a slight rearrangement of the terms, this expression becomes

drop along AB $= r_1 i_1 + (r_1 + r_2) i_2 + (r_1 + r_2 + r_3) i_3 + (r_1 + r_2 + r_3 + r_4) i_4$.

Now $r_1 = R_1$ is the resistance of the first section AC of the main; $r_1 + r_2 = R_2$ is the resistance of the portion AD, *i.e.*, the portion from A to the point at which the current i_2 is tapped off; similarly, $r_1 + r_2 + r_3 = R_3$ represents the resistance of the portion of the main from A up to the point where the current i_3 is tapped off, &c. We may therefore write:

drop along AB $= R_1 i_1 + R_2 i_2 + R_3 i_3 + R_4 i_4$. (2),

R_4 standing for $r_1 + r_2 + r_3 + r_4$. This equation gives the drop in a most convenient form for calculation.

It will be noticed that the total drop is

made up of a series of terms, each term consisting of the product of a current into the resistance of that portion of the main included between the point of supply (or "feeding-point") A and the point at which the current branches off. It is convenient to speak of such a product as the *moment of the current* about the feeding-point A, by analogy with the moment of a force about a point. Adopting this nomenclature, we may state the rule for finding the drop in the following simple and easily remembered form:

The total drop along a single main supplied with current at one end, and having currents branching off at intervals, is equal to the sum of the moments of the various branch-currents about the point of supply, or feeding-point.

We shall consider a simple numerical example to illustrate the application of this rule. In Fig. 3 is shown a main fed at the

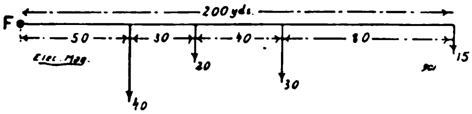


FIG. 3.

point F. The main is 200 yards long, and has a cross-section of $\frac{1}{8}$ sq. in. Currents of 40, 20, 30, and 15 amperes branch off at points distant respectively 50, 80, 120, and 200 yards from the feeding-point. The problem is to find the drop along the (single) main.

By reference to a wire table, we find that a main $\frac{1}{8}$ sq. in. in cross-section has a resistance of about .000196 ohm per yard. Hence we find $R_1 = .000196 \times 50 = .0098$; $R_2 = .000196 \times 80 = .0157$; $R_3 = .000196 \times 120 = .0235$; and $R_4 = .000196 \times 200 = .0392$.

Applying the rule given above, we find drop along main = sum of moments of currents

$= .0098 \times 40 + .0157 \times 20 + .0235 \times 30 + .0392 \times 15$

$= 1.999$, or practically 2 volts.

Hence the total drop along the *double main* (forward and return) is 4 volts.

A diagram such as the one shown in Fig. 3, which gives the distribution of the branch-currents, may conveniently be termed a *load diagram*.

The reader must be careful to note that in calculations of this kind we are concerned with the total drop along the *double* main, so that the result found as explained above for a single main must be multiplied by 2. Another method is to proceed as if there were a single main only, but having double the resistance of the actual single main.*

Graphical Determination of Drop.

Instead of the algebraical method just explained, a graphical method may be employed. In Fig. 4 is given a load diagram, FD representing the main, and A, B, C, and D the points at which currents are taken off. Horizontal distances along FD are supposed to represent, to a suitable scale, resistances, and the lengths of the vertical lines through A, B, C, and D, currents. In order to determine the drop, we adopt the following construction:

Take any vertical line, such as F′A′ in Fig. 4, and, starting from any point F′, lay off $F'A' = i_1$, $A'B' = i_2$, &c., to represent, to the same scale as that used in the load diagram, the various branch-currents. It is evident that $F'D' = i_1 + i_2 + i_3 + i_4$ represents the sum of all the branch-currents, and hence the current fed into the main at F. From D′ draw a horizontal line D′P, making D′P of such length that it represents a *unit resistance* on the scale of the load diagram. Join P to the points F′, A′, B′, and C′.

Next, returning to the load diagram, draw a series of vertical lines through F, A, B, C, and D (shown dotted in Fig. 4), and, taking any point *f* in the vertical through F, draw *fa* parallel to F′P until it intersects the

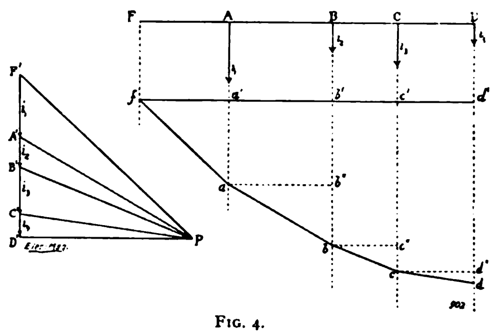


FIG. 4.

vertical through A at *a*; then draw *ab* parallel to A′P, *bc* parallel to B′P, *cd* parallel to C′P, and, lastly, *fd′* parallel to D′P (*i.e.*, horizontally). Then, as will be proved presently, *d′d* represents the total drop along the main.

Consider in the first place the triangle *fa′a*; since this is similar to PD′F′, we have $\frac{aa'}{fa'} = \frac{F'D'}{D'P} = F'D'$, since $D'P = 1$. Hence, $aa' = fa' \times F'D' = FA \times F'D'$ = resistance of first section of main × current in first section = drop in first section. Similarly, drawing *ab″* horizontally, and considering the two similar triangles *ab″b* and PD′A′, we show that *bb″* = drop along section AB

* The reader familiar with the theory of loaded beams will immediately recognise the fact that the problem of finding the drop along a distributing main fed at one end only is identical with that of finding the bending moment at the point of support of a beam fixed at one end only (*i.e.*, a cantilever).

of main. In the same manner, $c''c$ is shown to give the drop along BC, and $d''d$ the drop along CD. Hence total drop $= a'a + b''b + c''c + d''d = d'd$, as stated above.

In carrying out the construction in practice, one or two points deserve special attention. The drop of potential, it must be noted, is to be measured to the same scale as the currents. In order to secure accuracy, the diagram should be drawn to as large a scale as possible. Now if D′P were actually to be made unity on the resistance scale, as we have supposed it to be, its length would be very great in comparison with F′D′, and the lines radiating from P to the various points A′, B′, &c., would be nearly horizontal. The broken line *fabcd* would also consist of sections only slightly inclined to the horizontal, and as a result the method would be valueless in cases where a fair degree of accuracy is required. It therefore becomes advisable to modify the diagram so that the inclinations of the lines radiating from P are considerable. This may be easily done by making D′P equal not to unity, but to, say, .01 on the resistance scale (or any other convenient sub-multiple). Using the same reasoning as that which we employed when D′P was made equal to 1, we now find $\frac{aa'}{fa'} = \frac{F'D'}{D'P} = \frac{F'D'}{.01} = 100 \times F'D'$, and $d'd = 100 \times$ drop. The drop therefore appears exaggerated a hundred-fold, and may be measured much more accurately. Thus, P may be chosen *anywhere* on the horizontal through D′, provided we remember that if D′P $= n$ on the resistance scale, then the drop $= \frac{1}{n} \cdot dd'$; dd' being measured on the current scale.

The diagram *fabcdd′* in Fig. 4 is not the only one by means of which the drop may be graphically determined. In fact, there are, as will be seen presently, an infinite number of such diagrams. In Fig. 5, the diagram of Fig. 4 has, for the sake of comparison, been reproduced in dotted lines. Assuming, for the sake of simplicity, that D′P = 1, let us draw a vertical through P, and choose in it any point P′. Let P′ be joined to each of the points F′, A′, B′, C′, and D′, and, starting as before from any point f in the vertical through F (Fig. 4), let us (Fig. 5) draw $f\alpha$ parallel to F′P′; $\alpha\beta$ parallel to A′P′, &c.; and, lastly, $f\delta'$ parallel to D′P′ (just as in the former case fd' was drawn parallel to D′P). We shall show that $\delta\delta' = dd'$ represents the drop along the main.

By construction, the triangles $f\alpha\alpha'$ and P′F′D′; faa and F′P′P; and faa' and PF′D′, are respectively similar. Hence, $\frac{\alpha\alpha'}{F'D'} = \frac{f\alpha}{F'P'} = \frac{fa}{F'P} = \frac{aa'}{F'D'}$, so that $\alpha\alpha' = aa'$, and $\alpha\alpha'$ represents the drop along the first section of the main. By very similar reasoning, we show that $\beta\beta'' = bb''$ gives the drop along AB; and that $\gamma\gamma''$ and $\delta\delta''$ give, respectively, the drop along BC and CD (the lines $\alpha\beta''$, $\beta\gamma''$ and $\gamma\delta''$ have all been drawn parallel to $f\delta'$). From this it follows that $\delta\delta'$ represents the total drop. It is therefore not necessary (though simplest) to choose the point P′ in the horizontal through D′; it may be chosen in any position, provided it is at unit distance from F′D′. Even this latter restriction may be removed if we pay proper attention to the vertical scale; thus, if P is taken at a distance n from F′D′, then the drop $= \frac{1}{n} \cdot \delta\delta'$. The point P is termed the *pole*; and the polygon formed by the straight line $f\delta'$, and the broken line $f\alpha\beta\delta\gamma$ is known as a *link polygon* or *funicular polygon*.

It may be worth while to point out that in constructing the funicular polygon from the polar diagram any side such as $\beta\gamma$ of this polygon is drawn parallel to that line of the polar diagram (P′B′) whose extremity (B′) marks the boundary between the two currents (i_2 and i_3) which are tapped off at the ends (B and C, Fig. 4) of the corresponding section (BC) of the main. By Continental writers on the subject, the broken line $f\alpha\beta\gamma\delta$ is termed the *branch-current line*, and the straight line $f\delta'$ the *supply-current line*.

(*To be continued.*)

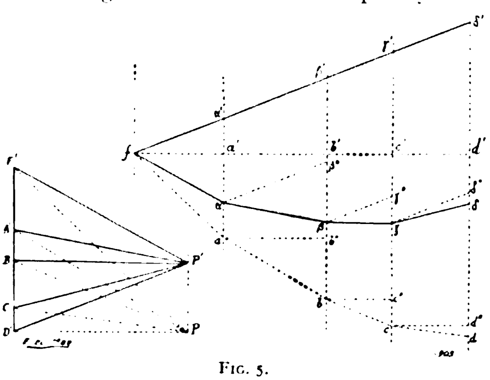


Fig. 5.

Problems in Dynamo Design. VII.

Armature Calculations: Drag on Armature Conductors.

By ELLIS. H. CRAPPER, M.I.E.E

When a conductor carrying a continuous current is placed in a magnetic field so that the current is in a direction at right angles to the lines of force of the field, the conductor experiences a

definite amount of mechanical force acting at right angles to the conductor itself, and also to the direction of the lines of force of the field, as indicated in Fig. 1. The magnitude of the force may be proved experimentally to be proportional to the intensity of the magnetic field, the strength of the current and to the length of the conductor. Each armature conductor of a dynamo thus experiences a certain amount of repelling force when traversed by a current, and it is in consequence of this that the armature has to be driven by some prime mover or source of power in order to overcome the opposition of the effort or drag acting upon the armature conductors by electrodynamic action, and thus enable an induced E.M.F. to be set up. It is well known by Lenz's Law, for instance, that the direction of the induced E.M.F. in the armature conductors of a dynamo, and consequently the direction of the resulting current, is such that it tends to stop the motion producing the E.M.F. This resistance to motion is technically known as *the drag on the armature conductors*, and is that which, in the case of dynamos, requires a driver or prime mover, whilst in the case of motors it is that which causes the armature to rotate.

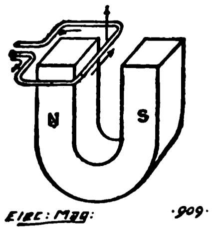


FIG. 1.

A moment's reflection makes it obvious that the drag on armature conductors varies with the position of the conductor relatively to the field magnet-poles, and is a maximum when the conductor passes through that part of the air-gap at which the flux-density is the greatest. For smooth-core armatures, the magnitude of the drag on the armature conductors may be found as follows:

If B = the flux-density of the field, which is assumed to be uniform,

C = the current,

l = the length of the conductor acted upon,

then $F = K \times B \times C \times l$,

where K is a constant, the value of which depends upon the system of units used. If l be in centimetres, and B and C be in absolute or C.G.S. units, then for the mechanical force F to be given in dynes K will be unity, and

$$F = B \times C \times l \text{ dynes.}$$

If the current C be given in amperes, then $K = \frac{1}{10}$, and

$$F = \tfrac{1}{10} B\,C\,l \text{ dynes.}$$

If the length of the conductor be given as l_1 feet or l_{11} inches, then

$$F = \tfrac{1}{10} \times 2.54\,B\,C\,l_{11} = 0.254\,B\,C\,l_{11} \text{ dynes,}$$

$$\text{or } F = \tfrac{1}{10} \times 12 \times 2.54\,B\,C\,l_1$$
$$= 3.048\,B\,C\,l_1 \text{ dynes.}$$

If the force experienced be required in pounds-weight the conversion may be readily effected by introducing the dimensional constants:

Force of 981 dynes = weight of one gramme

One pound = 453.6 grammes.

Thus,

$$F = \frac{B\,C\,l}{10 \times 981 \times 453.6} \text{ pounds-weight}$$
$$= \frac{0.254\,B\,C\,l_{11}}{981 \times 453.6} \text{ pounds-weight}$$
$$= \frac{3.048\,B\,C\,l_1}{981 \times 453.6} = \frac{B\,C\,l_1}{146000} \text{ pounds-weight}$$
$$F = 0.00000685\,B\,C\,l_1 \text{ pounds-weight.}$$

EXAMPLE 1.—*A wire carrying* 100 *amperes is placed in a uniform magnetic field of* 10,000 *units strength so that it makes an angle of* 45° *with a plane normal to the direction of the lines of force. Determine the force experienced per foot-length of the wire.*

When the conductor is inclined to the plane normal to the flux the force experienced by the conductor is proportional to the length of the projection of the conductor upon the normal plane, so that the effect length of the conductor in this example is

$$1 \text{ foot} \times \cos 45^\circ = \frac{1}{\sqrt{2}} \text{ foot.}$$

$$\therefore \quad F\,(\text{lbs.}) = \frac{B\,C\,l_1}{146000} = \frac{10000 \times 100 \times \frac{1}{\sqrt{2}}}{146000}$$
$$= 4.845 \text{ lbs.}$$

EXAMPLE 2.—*The armature of a bipolar dynamo is* 20 *inches in length and* 0.916 *foot diameter and consists of* 80 *conductors. The angle of embrace is* 130° *and the armature delivers* 326 *amperes. The intensity of the field in the air-gap is* 6,700 *lines per square centimetre. Determine* (1) *the drag on the armature;* (2) *the torque required and the energy expended in producing the output of* 326 *amperes at* 108 *volts when the speed is* 750 *revolutions per minute.*

To determine the total pull on the armature when delivering current, the lack of uniformity in the intensity of the field between the pole-pieces must be taken into account, and it is customary to take the conductors subtended by the poles as being actively concerned in the drag on the armature as a whole. Thus, if θ be the angle of polar embrace, the number of conductors acted upon is

$$Z_1 = Z \times \frac{2\theta}{360} = \frac{\theta}{180} Z$$

where Z is the total number of conductors

on the armature. It must also be borne in mind that in bipolar machine the current in each armature is one-half of the total current; therefore if P denote the total pull on the armature,

$$P = \frac{1}{10} B \times \frac{Ca}{2} \times l \times \frac{\theta}{180} Z \text{ dynes}$$

$$= \frac{1}{146000} \times B \times \frac{Ca}{2} \times l_1 \times \frac{\theta}{180} Z \text{ lbs.-weight}$$

and in the example under consideration

$$P = \frac{1}{146000} \times 6700 \times \frac{326}{2} \times \frac{20}{12} \times \frac{130}{180} \times 80 \text{ lbs.}$$

$$= \frac{67 \times 163 \times 13 \times 80}{146 \times 6 \times 18} \text{ lbs.}$$

$$= 720 \text{ lbs.}$$

The torque or turning moment experienced at the circumference of the armature is given by the product of the total peripheral force into the radius, therefore,

$$T \text{ (torque)} = 720 \times \frac{0.916}{2}$$

$$= 329.76 \text{ pound-feet.}$$

Now the work done per revolution is $720 \times 0.916\,\pi$ foot-pounds, so that the power required is

$$\text{Power} = \frac{720 \times 0.916\,\pi \times 750}{33000}$$

$$= 47 \text{ h.p.}$$

This is slightly less than the output of 47.2 h.p. (electrical) corresponding to 326 amperes at 108 volts.

(*To be continued.*)

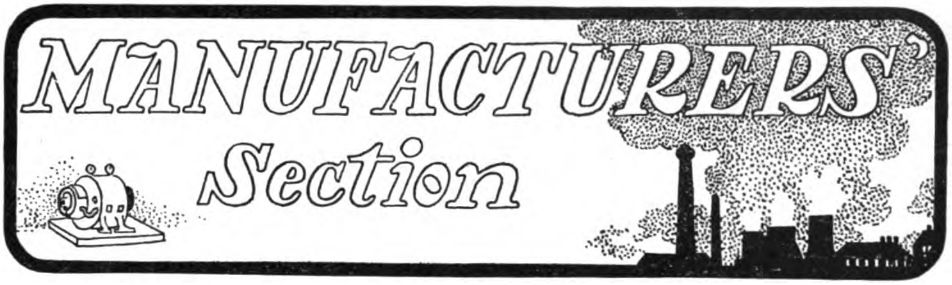
From Professor to Student.

Being employed by the Manchester Corporation Electric Works, I am unable to attend the technical school. Would you advise me to take a course in a correspondence school, and if so, could you give me the address of one?

We see no reason why the fact of our correspondent's being employed by the Manchester Corporation should prevent his attending an evening class, and this is the course we should strongly urge him to take. Even if his services are required during the evening, his employers would probably be quite willing to adopt some arrangement by means of which he could devote at least one evening a week to attending a suitable class. We happen to know of similar cases, and our experience is that central station engineers are only too glad to give their staff every reasonable facility for self-improvement. But should such an arrangement be really impossible, we think that our correspondent would do well to try a correspondence class. He might write to Prof. Jamieson, M.Inst.C.E., Kelvinside, Glasgow, asking for particulars regarding his correspondence classes.

I have a fair knowledge of mathematics (including the calculus), and have recently left college. What are the best books on the mathematical theory of electricity, and how much more mathematics shall I want to read them?

We should recommend our correspondent to begin with Prof. J. J. Thomson's *Elements of the Mathematical Theory of Electricity and Magnetism* (Cambridge: at the University Press), as this is undoubtedly the best introduction to the subject. If our correspondent prefers a book which combines theory with experimental details, we can recommend the second edition of Joubert's *Elementary Treatise on Electricity and Magnetism*, by G. Carey Foster and A. W. Porter (Longmans and Co.). No knowledge of mathematics beyond that already possessed by our correspondent is required for the reading of these two books. When these have been mastered, we should advise him to try A. G. Webster's *Theory of Electricity and Magnetism* (Macmillan and Co.); this involves mathematics of a somewhat higher order, including analytical solid geometry; but fortunately for the reader, most of the mathematical methods employed are lucidly explained by the author in the introductory portion of the work. Then there is Maxwell's great treatise, with the supplementary volume of J. J. Thomson's *Recent Researches in Electricity and Magnetism* (Clarendon Press). Lastly, we may mention Oliver Heaviside's *Electrical Papers* (Macmillan and Co.) and his *Electromagnetic Theory* ("The Electrician" Printing and Publishing Co., Ltd.).

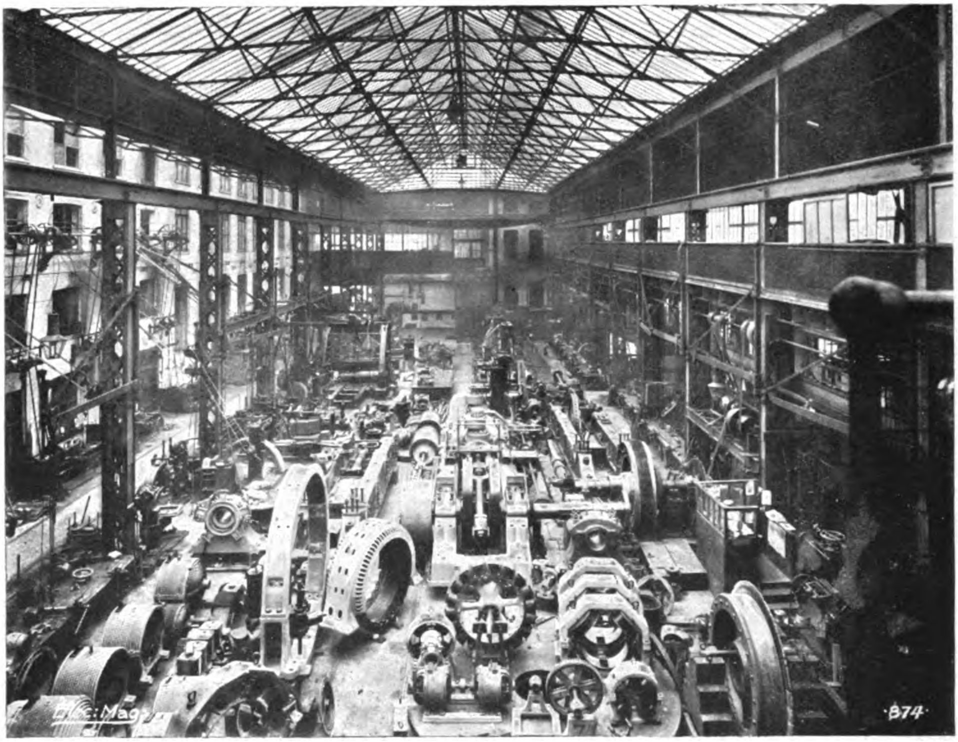


A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section at end of Magazine.

The Works and Electrical Products of Mather and Platt, Limited.

THERE are few electrical manufacturing establishments in this country which have afforded us so much pleasure to inspect and describe as that of Mather and Platt, Ltd., Salford Iron Works, Manchester. We take pardonable pride in recording the progress of an undertaking whose associations with electrical enterprise have been accompanied by results now finding expression in every known corner of the industrial world, results achieved in the pioneering times of ridicule and obstruction, when only dogged perseverance and fixity of purpose accomplished anything.

Mather and Platt, Ltd., hold an electrical record which would be hard to beat and difficult even to approach in this country. In these days of "hustle" and "push" our industrial ancestors are too often forgotten, the arduous exertions of pioneers are overlooked and the all-absorbing present seeks to draw a veil over the all-important past. Again, how often has not the scion of some great enterprise of to-day been overwhelmed with the very wave of progress he has created, and on whose crest he should have been carried with the tide! These sentiments may seem difficult of application to the commercial uprising of a great firm, but we think they have some bearing on the subject of our remarks, in that we are continually asked to feed on "facts and figures" proving that in electrical matters British enterprise has been weighed and found wanting; that we are being overwhelmed by German and American competitors, and that from the start we have failed to hold our own. As an answer to these statements we would point to that business acumen which originally prompted Mr. (now Sir) William Mather to undertake the commercial exploitation of dynamo electrical machinery in this country, and to that fund of commercial resource which has enabled his company to reach and maintain the position it holds to-day. As far back as 1882 the manufacture of the Edison Hopkinson dynamo was taken up, and the many improvements introduced at once ensured success in its exploitation. The labours of Drs. J. and E. Hopkinson in perfecting this machine are well reflected in its remarkable performance, and though it has been now practically superseded, it must ever live in the memory of electrical men as that link between theory and advanced practice without which the great gulf between the two would never have been bridged. From this comparatively insignificant nucleus a flourishing business has developed and grown to dimensions almost rivalling the other important industries in which the firm have been engaged for over seventy years. The entire possibilities of the situation in electrical matters was recognised from the outset and provision made to manufacture the chief types of heavy machines, engines, generators, motors, and pumps. To these we shall refer in detail later. Pioneer work in electric railways and tramways was also undertaken, the Bessbrook and Newry and Douglas and Laxey lines being witnesses to the skill then prevailing in this field. We need hardly refer to the development of the three- and five-wire systems at Manchester under Dr. John Hopkinson and to the large "bi-polars" which for a long while did good service at the Dickinson Street



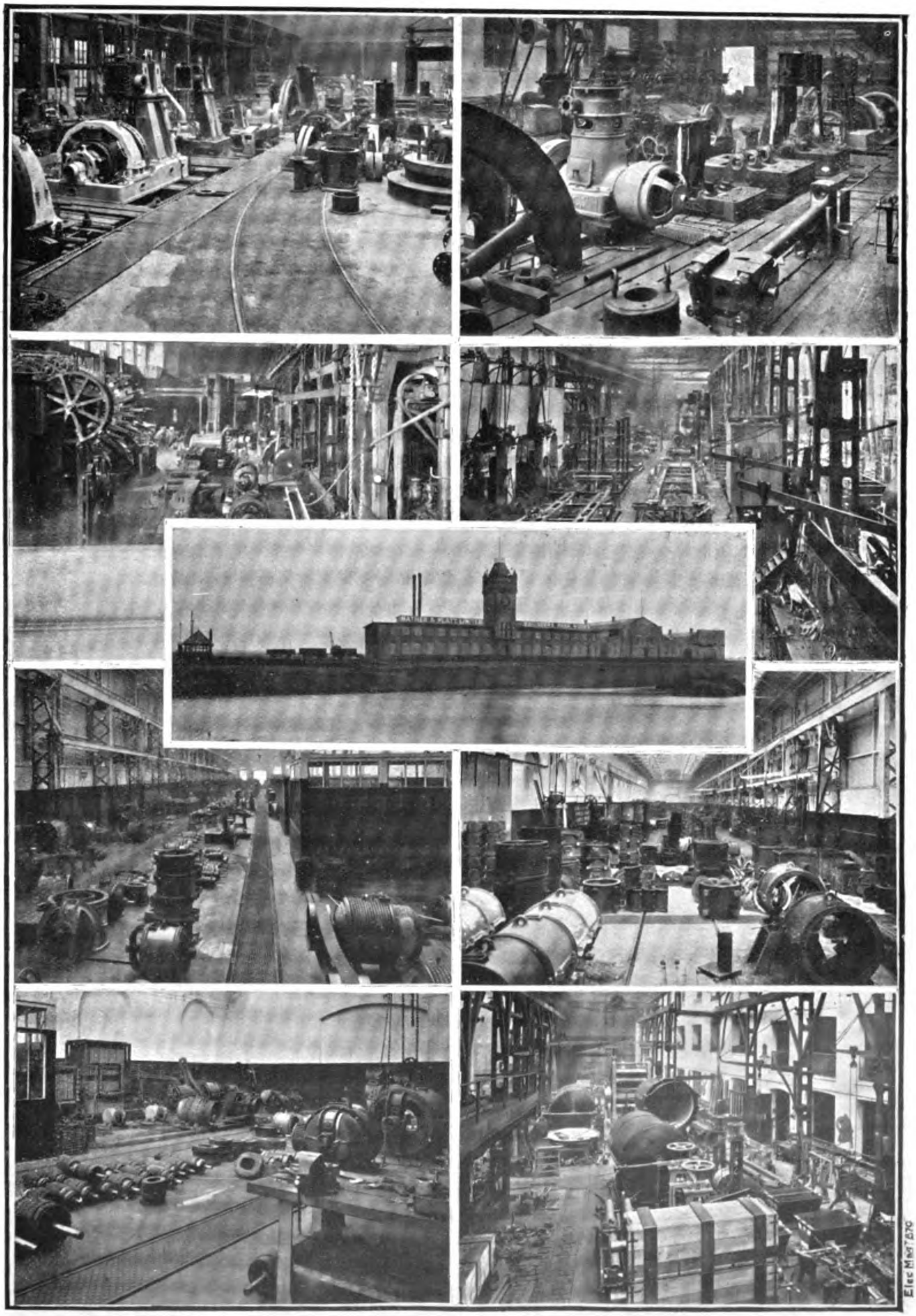
ELECTRICAL AND ENGINE-ERECTING SHOP, SALFORD IRON WORKS.

Station. There does not seem to be a single branch of heavy electrical engineering which is not indebted to the pioneer work of Mather and Platt.

At the present time the company is prepared to contract for the complete electrical equipment of large central stations, either direct or alternate current. Although there were no signs on our recent visit to the works of any very large machinery going through, it appeared that a good business was being done in the manufacture of apparatus for which there is a ready sale both in this country and abroad, chiefly the colonies.

The Works.—At the Salford Iron Works the bulk of the textile, engine, dynamo, and pump work is carried out. The motor department has been transferred to the company's fine new works at Newton Heath, Manchester, where a new motor shop adjoining the main building has been erected, but reference to this will be made later.

We shall not burden our readers with the stereotyped journey through the shops, but rather refer briefly to these and their equipment. It will be readily understood that a works established so many years ago would need continued extension and adaptation with advancing time. In erecting modern works, so much can be gathered from past experience that the ideal almost can be embodied in the complete scheme. Modern framework, lighting, driving, and tools can all be assembled forming a uniform whole. Works handed down from father to son must undergo modification, and this is noticeable in the Salford Iron Works. Beams and walls bearing the mark of time enclose tools and machinery youthful in comparison. A walk through the various departments gives a first impression of decoherence, but this is immediately dispelled by a glance at the workers and the methodical, almost mechanical connection between shop and shop. The entry of the raw material to foundry or stores is followed by a regular succession of processes which appear continuous until the finished article is reached. Two large brass and iron foundries supply the bulk of the castings for all departments and an ample forge is kept constantly busy. Electric driving is prevalent throughout the works, the motors being grouped on lines of shafting and separate shops, except in the case of heavy machines, which are individually driven. From foundry and forge the various parts which go to make up complete



Erecting Shop, Salford Iron Works.
Printing-Machine Shop, Salford Iron Works.
Motor Shop, Park Works.
Motor Shop, Park Works.

Park Works.

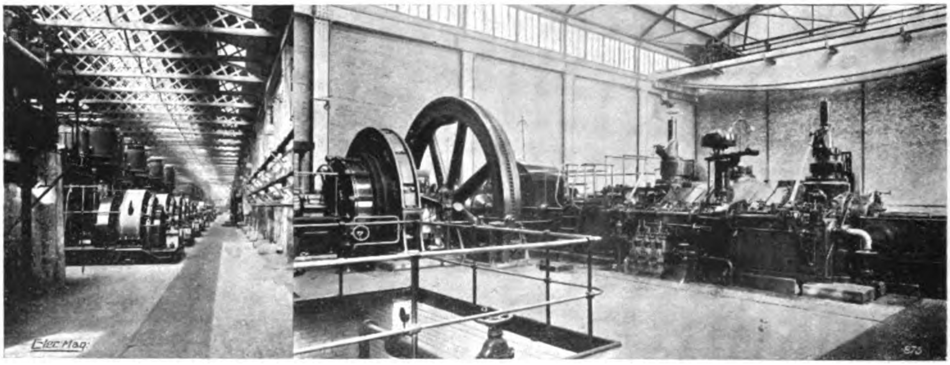
Erecting Shop, Salford Iron Works.
First Textile Shop, Salford Iron Works.
Motor Shop, Park Works.
Second Textile Shop, Salford Iron Works.

apparatus are passed through turning, milling, planing, and drilling departments into one of the three principal fitting-shops, all of which are better depicted by the adjoining composite photograph (p. 515), than by any word-painting of ours and we would refer our readers to this, while dismissing the subject by saying that everything now possible of attainment by the aid of modern machine tools, electric driving and rigorous methods, is effected by these means in the establishment we are attempting to describe. We may mention before quitting the subject that the power for driving is partly furnished by Manchester dynamos, driven by belt from a countershaft, in turn operated by belt from two engines which have been running since 1887, and speak more than words can for those early laborious efforts from which a great industry has arisen. The dynamos have given complete satisfaction and have "stood up" to almost any load imposed upon them. Adjoining are two of the first "high speeders" built by the firm, both Edison-Hopkinson dynamos and engines, and these appeared fit for anything.

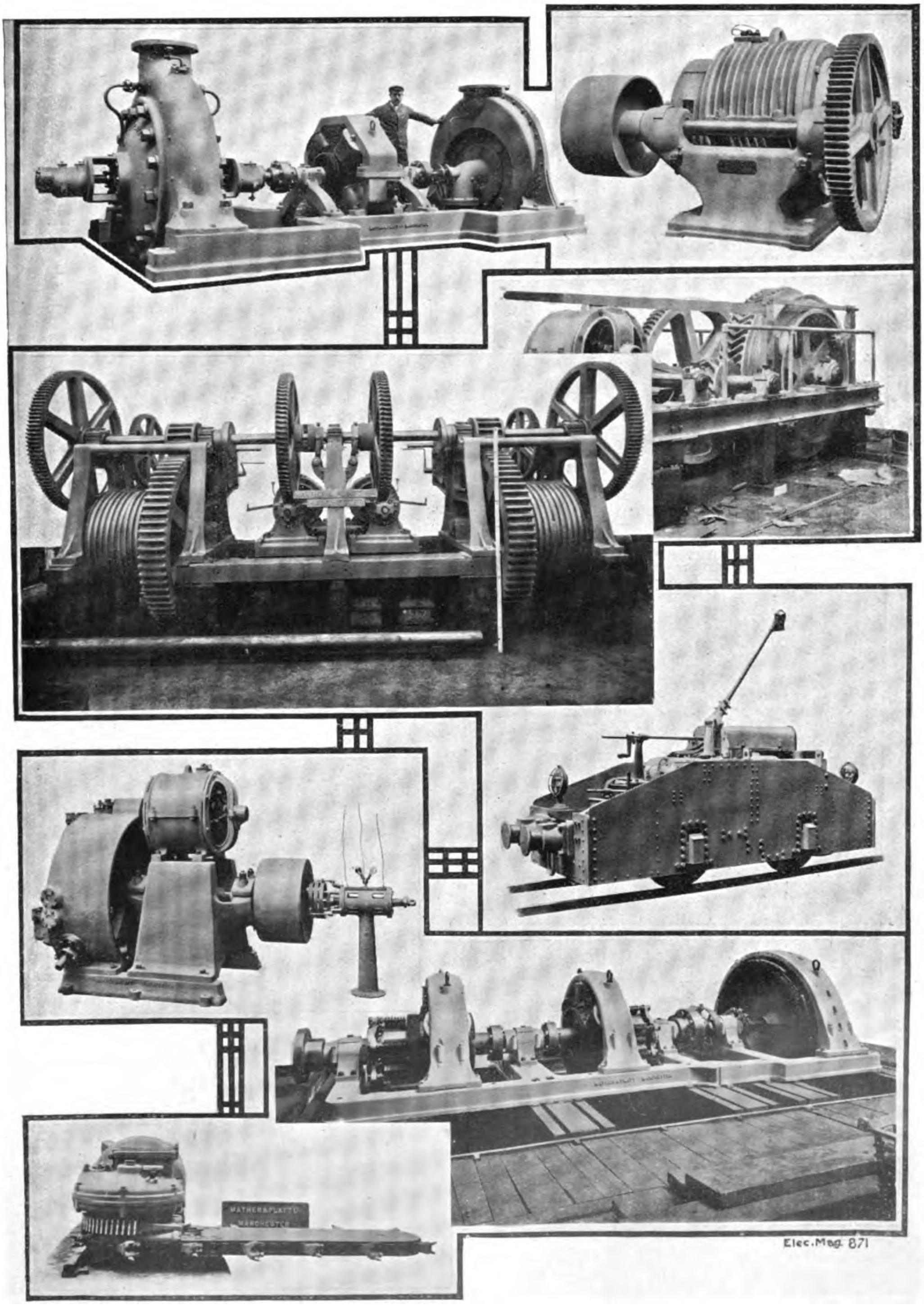
Chief Electrical Products.—As already indicated, the manufactures of Mather and Platt, Ltd., in so far as they concern electrical machinery, are of a varied character, but none the less important or up-to-date in their design. A progressive attitude has been maintained in regard to prime movers, the steam-engine having been made in special sizes for many years, and recently the rights to manufacture the Körting gas-engine have been acquired and vigorously worked. In technical machinery the highest standard of excellence has been constantly maintained, and the dynamos and motors manufactured are marked by characteristic features. Condensing plants have been made a speciality and are now an important factor in the output; while turbine pumps for both high and low lifts as an accessory to the electric motor are being turned out in great quantities. The possibilities of electric driving for textile machinery have been recognised to the full, and the combination of motor and machine, by reason of their joint production under one management, is effected with the minimum of trouble. Coal-cutters and electric locomotives are also to be numbered among the products. The above summarises the chief manufactures of the company, but for the benefit of our readers we will deal with these somewhat at length, referring to each type in a separate paragraph for ready reference.

Steam-Engines. — These are made compound and triple expansion, in sizes from 70 to 750 h.p. of the vertical type. They are double-acting open marine type for condensing or non-condensing, and speeds between 250 and 120 r.p.m. There is also a special line of small enclosed single-acting engines for ship and country-house lighting. The dynamo is overhung in this latter case and the whole unit is exceedingly compact. The large engines are in extensive use, one contract being for eight 750 h.p. sets supplied to the Castner Kellner Co.'s power-house at Runcorn. Certain of these sets have been kept running seven months without stop and on 25 per cent. overload.

Condensing Plant.—Auxiliary machinery for boiler and engine house, such as condensers, cooling-towers, air and circulating pumps, feed pumps and feed-water filters are made and supplied. The condensers made are of the ejector type for small sizes and surface for larger powers. The latter are made up complete with air and circulating pumps, steam or electrically driven. An evaporative condenser requiring a minimum of cooling water and



750-HP. GAS-ENGINE AND 500-KW. DYNAMO, EIGHT SETS TRIPLE-EXPANSION STEAM-ENGINES AND 400-KW. DYNAMOS, EIGHT SETS COMPOUND STEAM-ENGINE 250-KW. DYNAMOS. TOTAL OF OVER 10,000 H.P.



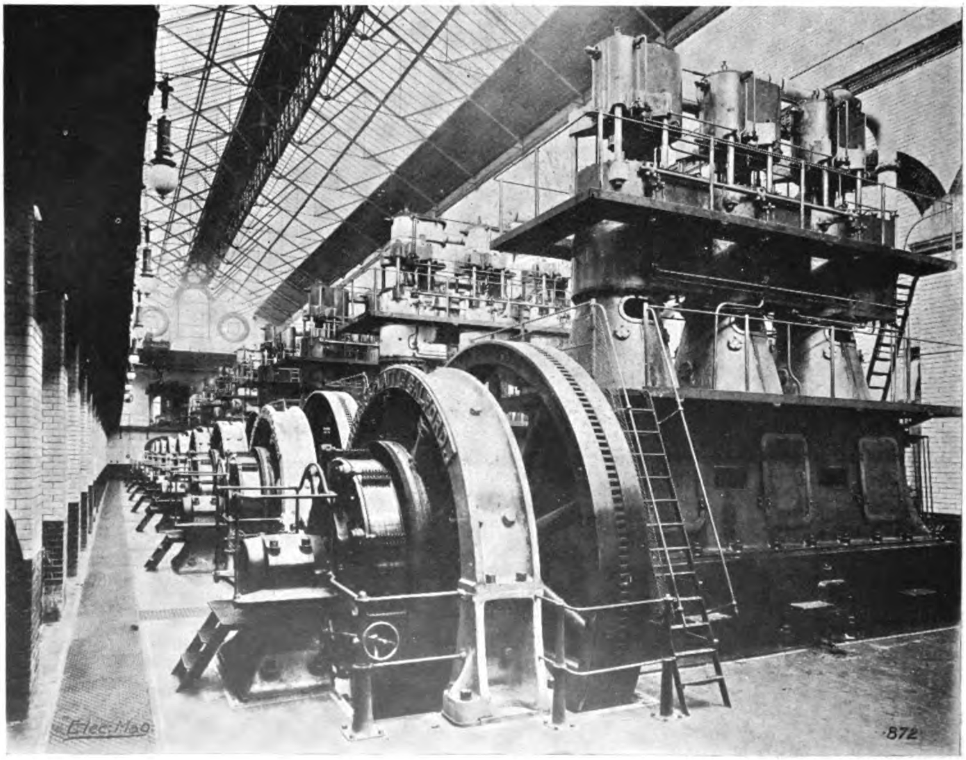
High-Lift Turbine Pump and Motor.
Electrically-driven Gear at Barking Bridge.
Automatically-controlled Electrically-driven Pump.
Electric Coal Cutter.

Back-Geared Motor.
Electric Hauling Gear.
Electric Locomotive.
Combined Direct-Current and Alternate-Current Machines for Johannesburg.

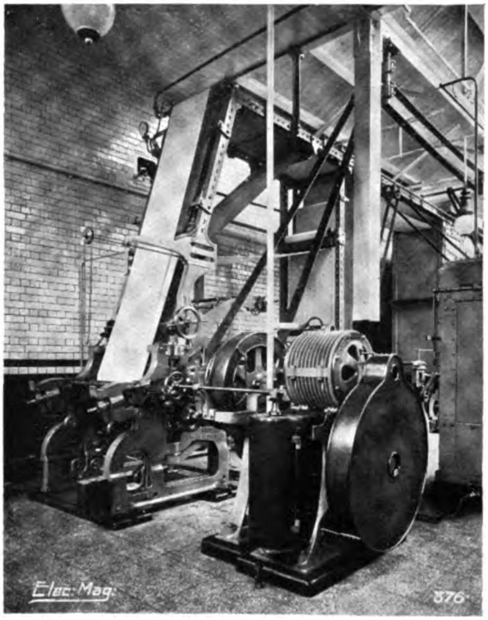
comprising a stack of pipes over which water is sprayed, is another speciality of this department.

Gas-Engines.—We need not expatiate on the future of the gas-engine and its possible influence on the electrical industry. The acquisition by the firm of rights to manufacture in this country a well-known and tried type from the Continent is sufficiently indicative of the possibilities of this prime mover. The engines are Körting horizontal, two cycle single cylinder machines, and have secured for themselves a wide reputation, especially in connection with electricity generation. Mather and Platt, Ltd., have executed a number of orders for combined units, the generator being also of their own make. Space will not permit us to detail the construction of the engine, but we may say that its principle admits in practice of an even turning moment, regularity in running and economy in working. By the use of separate gas and air pumps there is no accumulation of explosive mixture outside the combustion cylinder, and the air-pump in addition provides a scavenging charge of pure air at the end of each cycle. We illustrate a large 750-h.p. engine and 500 kw. generator as running at the Castner Kellner Alkali Works, the steam-engines, to which we referred above, being also shown on the left of the picture (p. 516).

Multipolar Dynamos.—These are made a special line of, and their manufacture has done much to make the reputation of the company. Standard machines are made from 14 kw. 100 volts to 1,000 kw. 550 volts. A circular or angular steel yoke ring is used with inwardly radiating poles, these being cast into the ring, except in large sizes. Former wound field coils are slipped over the poles and held in position by bolts passing through lugs on the flanges of the spools. The armature core is built up in the usual way, with ample spaces for ventilation. The commutator is of hard drawn copper bars mica insulated, the whole held firm by clamping rings carried on a cast-iron bush keyed on to the shaft. A typical installation of large machines for a normal load of 800 kw. each is that in the Salford Corporation Electricity Works, Strawberry Road, where eight units have been doing good service on tramway and lighting loads for some time past. The engines are by Browett, Lindley and Co., Patricroft, Manchester.



SALFORD ELECTRICITY WORKS



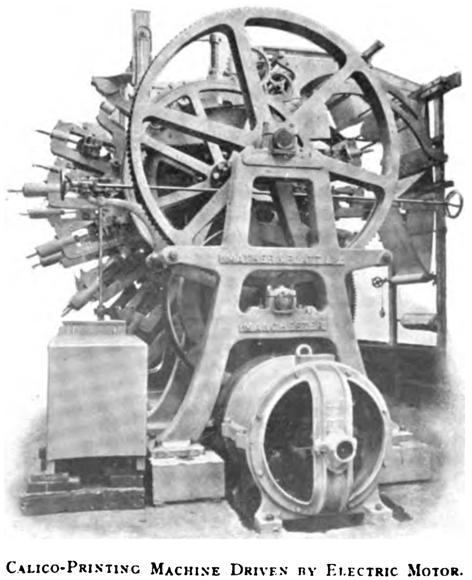
ELECTRICALLY-DRIVEN CALICO-PRINTING MACHINE. MANCHESTER MUNICIPAL SCHOOL OF TECHNOLOGY.

Numerous other important contracts have been completed for municipal authorities, among which we may mention Edinburgh, Doncaster, Poplar, Battersea, Gloucester.

Polyphase Machinery.—Polyphase machines have also been manufactured for some time by the company; the generators are of the revolving field type with stationary external armature. Polyphase motors of the usual squirrel-cage type are manufactured in sizes from 5 to 500 h.p., but these are made at the Salford Iron Works in a gallery over one of the main shops.

Motors.—The increasing activity among power companies supplying electrical energy in bulk over wide areas is stimulating the trade in motors to a remarkable degree. To meet the already large and steady demand for these, standard types of both alternate-current and direct-current machines were got out some years since, and many hundreds have been installed. As makers of textile machinery, and situate as they are in the heart of the cotton district of Lancashire, the company is in a unique position to advise on the best steps to be taken in applying electro motors to machinery once driven by steam. Further, the order placed for the one piece of apparatus can also be entrusted to the same makers, and the customer can rely on prompt delivery as well as an accurate combination of what are really two distinct types of machine. There are few, if any, firms who can claim facilities for affecting a combination of widely divergent designs of apparatus so readily, with maximum efficiency and minimum delay. This may be said for plant other than that for textile work, the pumps, condensers, coal-cutters, &c., being all fitted with motors and controlling gear all made under the same management.

Direct-Current Motors.—We have already mentioned the special motor shop adjoining the Newton Heath Works, and in dealing with motors we may refer to this at some length. The building is situated at the east end of the main works and is lighted entirely from the roof. At the south end is a stores for the cast-steel frames and covers which are picked up by a 10-ton electric crane and passed first through machines for milling, planing, drilling, and boring, all of which are located near the stores and electrically driven. Winding of both field and armature coils is carried on near the middle of the shop, such accessories as drying ovens, soldering plant, core presses, &c, being all suitably placed to facilitate the progress of the material to the finished product. Assembling is done at the north end, where the testing-plate and instrument room are also located. On the west side is a spacious store for small parts, finished coils and accessories. Walking down the shop the motors may almost be said to grow under one's eyes, until the machine, tested and approved, is finally reached. The wisdom of conducting this section of the electrical department distinct has been well justified by results. The motors are made in sizes from 1 to 190 h.p. and are of the open, protected, dust and flame proof, and totally enclosed types.



CALICO-PRINTING MACHINE DRIVEN BY ELECTRIC MOTOR.

Motor Applications. — Under this heading we propose to refer to several important devices which are made and equipped by the company with their own motors.

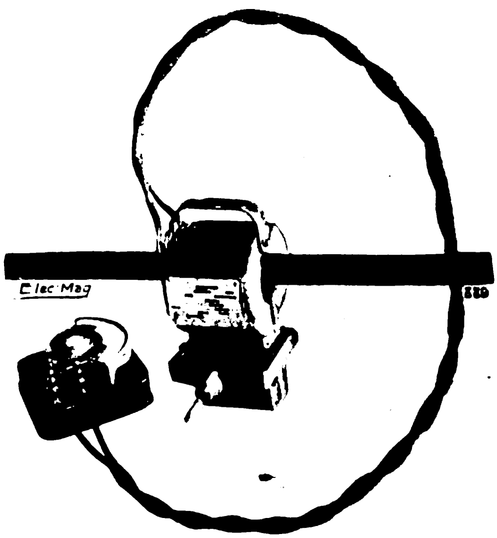
High-Lift Turbine Pumps.—The high rotative speeds permissible with the electromotor have naturally occasioned changes in the design of apparatus originally steam driven. Among pumping devices the centrifugal has been most readily adapted to high motor speeds, and with Mather and Platt's turbine pump great success has been achieved. The pump consists essentially of one or more sets of vanes, each set running in its own chamber, but fixed to a common shaft. Additional chambers increase the head under which the pump will work, and by placing pumps in series heads up to 2,000 ft. can be successfully negotiated.

General. — Among other specialities we may mention electric locomotives, overhead transporters, coal-cutters, hauling gears, and almost every class of textile machine. We give a composite photograph illustrating the chief apparatus made, and to which motors have been applied. A detailed description of these is not necessary. They serve their purpose in indicating the very broad field of enterprise which the company has undertaken to cover. They show also how the domain of engineering once occupied by steam is being gradually entered, despite all opposition. With little or no ostentation, the electrical products of Mather and Platt have found their way into all parts of the empire The old country has at least one establishment making practical answer to the present outcry of British commercial decadence, and the embodiment of this reply in the shape of good design, sound workmanship and practical efficiency, such as are noticeable in Mather and Platt's electrical manufactures, is worth more than all the weight of argument which can be brought to bear on the subject.

Conclusion. — We cannot conclude this brief survey of an extensive undertaking without thanking the management for their courtesy in showing us round the works and in placing photographs and data at our disposal. We were much impressed by our visit and left the works convinced that what British enterprise and capital can do in one case they can do in others. The electrical work required in this country and its colonies might well be in the hands of British electrical engineers, and the labours of Mather and Platt, Ltd., may be regarded as tending to establish a high reputation for home electrical products. In the heat of competition now everywhere evident, and for many years growing in intensity—a universal competition, we might say—the survival of a pioneer concern in an industry marked by some instances of failure is a matter for congratulation. The support accorded home industries is clearly evidenced in the case of Mather and Platt, Ltd., and we wish them, in concluding this account, that fuller measure of success to which, as fathers of our industry, they are justly entitled.

A NEW CABLE-TESTING TRANSFORMER.

A most interesting cable-testing current transformer set has recently been brought out at Schenectady by the General Electric Co. of the types shown in the accompanying illustration, Figs. 1 and 2. The special transformer has a hinged magnetic circuit as indicated in Fig. 1 and is utilised for testing in connection with a Thomson inclined coil portable ammeter as arranged in Fig 2. The design of the transformer is such as to give a most compact form as well as being accurate and convenient for testing work. The hinged and clamping points are so arranged as to give an excellent magnetic path, the locking device giving a contact positive and uniform, at the same time easily manipulated. Specially treated iron is employed for the magnetic circuit which is thoroughly laminated, the windings being placed on either arm of the hinged magnetic circuit. These windings are intended to stand a pressure of 2,300 volts



Transformer in Position on Cable.

CABLE TRANSFORMER, OPEN.

between them and the core, and are of 5 amperes capacity. The transformer can be clamped in position around any conductor and a flexible duplex cable is led to the ammeter which may be 40 feet away if desired. The weight of the transformer and ammeter is about 25 lbs. and the former is said to maintain its ratio accuracy from 25 per cent. overload down to $\frac{1}{8}$ of the normal load. These testing sets are very convenient for use in commercial service as well as in the modern laboratory in determining the load on feeders and distribution networks as well as in scientific experiments.

AUTOMATIC BOILER-FEED REGULATORS.

We need hardly emphasise the importance of maintaining a constant water level in boilers. Obviously this desired end is only procurable by automatic means. Heretofore the difficulty has been to regulate the feed automatically, by apparatus external to the boiler. Now, however, this obstacle has been surmounted, and the thing can be done by an external device, just introduced by Messrs. Holden and Brook, Serino Works, Manchester. We give two views of the device, the operation of which is as follows: It is attached direct to the boiler, or to a seating or water column by the flange A with the top-side O of the passage B fixed on the same line as the required water level.

The feed on its way to the boiler passes through inlet C and chamber D and then out at E the object of this circulation being to cool the water from the boiler entering the expansion tube F. As long as tube F is open to the steam space in the boiler it remains full of steam, and the feed-water is passing through D simply gets heated by its contact with the tube, but the moment the steam supply from the boiler is shut off by the rising of the water level and closing of the passage B, the cold (or partially cold) water surrounding the expansion tube condenses the steam in it and causes the water from the boiler to take its place, and so by partially or wholly filling the tube with water, partially cooled down by the feed-water passing through the chamber D, a marked difference is effected between the temperature of the tube when full of steam and extended, and when full of water and contracted. When the water level drops below the line O (say to N), the water in the tube F runs out by gravity, and being replaced with steam is thereby expanded and extended to its full length. This extension relieves the rods G and G_1 and the lever H, and by so doing allows the pull of the spring I to act upon the lever J (the pressure of which on the rod K has been relieved by the easing

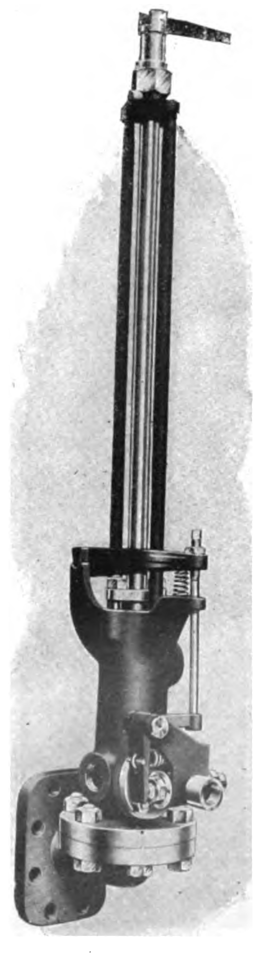


FIG. I. AUTOMATIC FEED REGULATOR

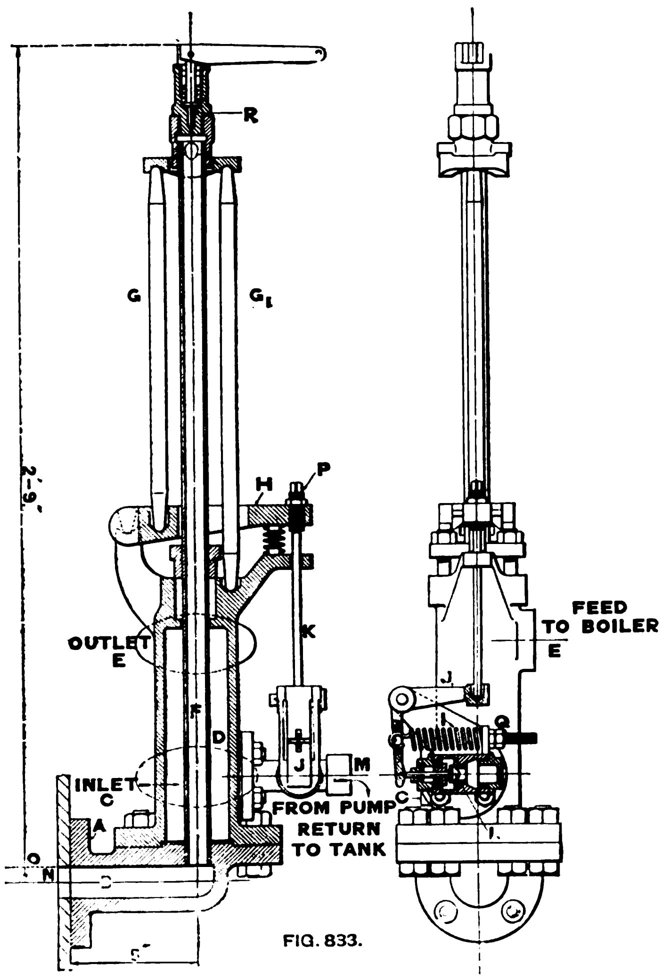
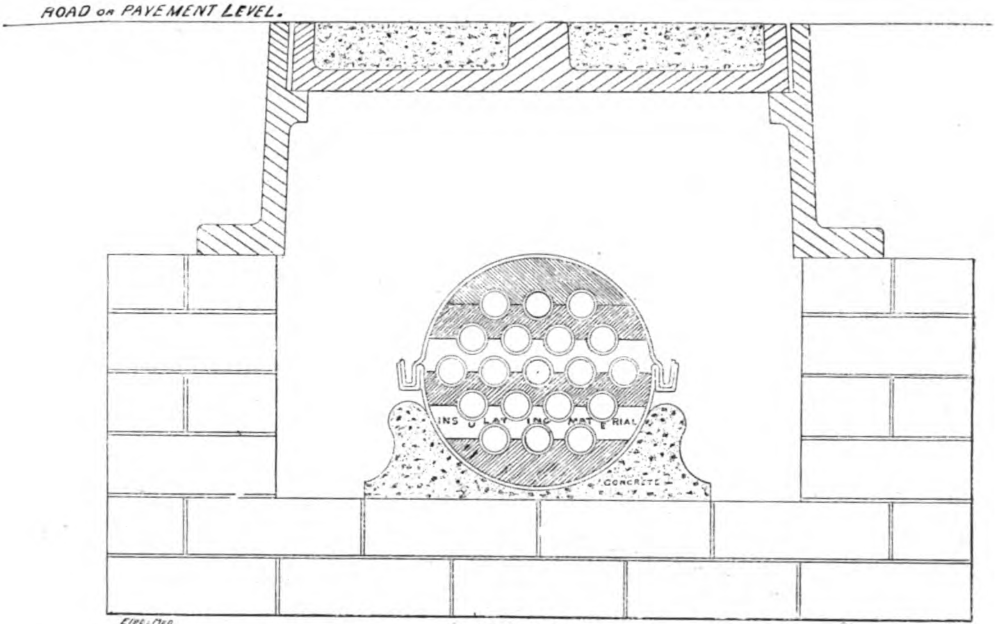


FIG. 2. SECTION THROUGH AUTOMATIC FEED REGULATOR.

off of the lever H), thereby pushing down and closing the by-pass valve L. On the other hand, when the water level rises and water rises in the tube F and contracts it, the pressure on the rods G and G_1 depresses the lever H and rod K, and by relieving the spindle of the valve L of the pressure of the spring I (by the depression of the lever J) leaves the by-pass valve L free to open. In the form of Regulator illustrated, the valve L acts as a by-pass on the feed-pipe from the pump to the boiler. In other cases, it is arranged to act as the actual boiler feed-control valve, or again it is arranged to control the steam supply of the pumps. Referring to the actual arrangement in Fig. 2, when the tube F is contracted and the by-pass valve L free to open, the water from the pump, instead of passing into the boiler, is diverted out at M into the supply tank. Again, the re-expansion of the tube F and consequent release of the lever J brings the spring I into action, recloses the by-pass, and by again forcing the feed to enter the boiler causes the water level to rise from N to O. On reaching the latter point the access of steam from the boiler to the tube F ceases, and therefore, as no further supply can then enter it, the steam it contains is condensed by the feed-water circulating round the tube on its way through the chamber D, so that water from the boiler flows in to fill the vacuum so caused and the tube becomes full of water, which in its turn also being similarly cooled lower down in the chamber D, the temperature of the latter is lowered, water entering the tube at a temperature much below that of the water in the boiler. Thus a marked contraction of the tube at once takes place, and by this contraction intense pressure is brought to bear on the rods G and G_1, which, in their turn, press down the lever H and rod K, with the result that the bell-crank lever J is forced away from the end of the by-pass spindle, leaving the latter free to open. As soon as the by-pass opens the feed ceases (or partially ceases) to enter the boiler, the water level stops rising and either maintains its level at a point at or about O or sinks a little lower to N, according to circumstances. When this takes place the water leaves the tube F by gravity, steam takes its place, the tube expands, the spring I closes down the by-pass (either wholly or partially according to the water level) and the water again enters the boiler.

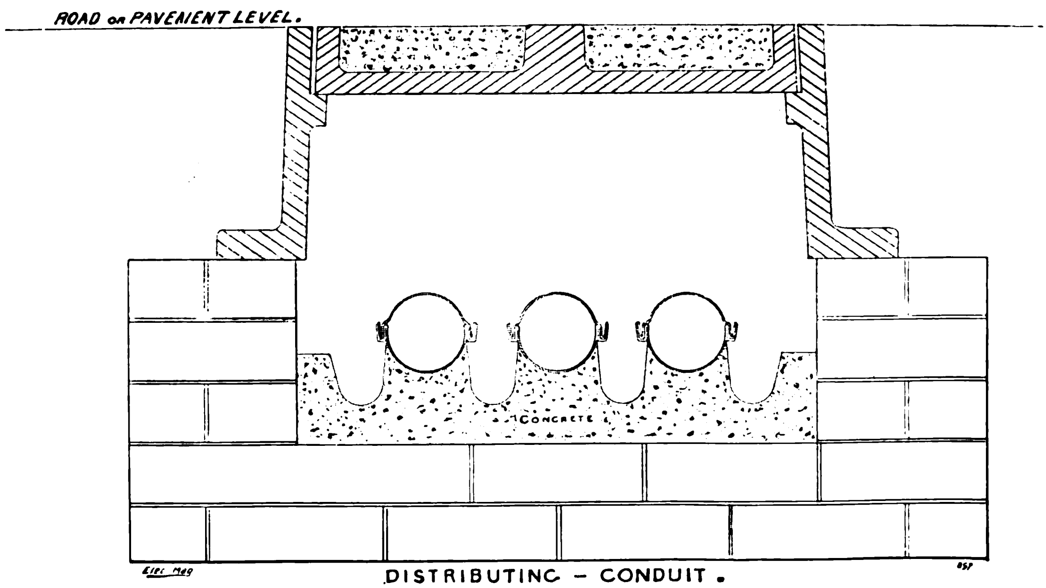
A NEW FORM OF CABLE CONDUIT.

THE problem of satisfactorily putting cables underground has often been tackled and as many apparently satisfactory solutions been frequently offered. We are in a position to record yet another which at least can lay claim to distinct novelty without fear of question. Mr. G. Wyndham Edwards, Kenilworth Court, Putney, has kindly furnished drawings of a pipe with his



MAIN-CONDUIT.

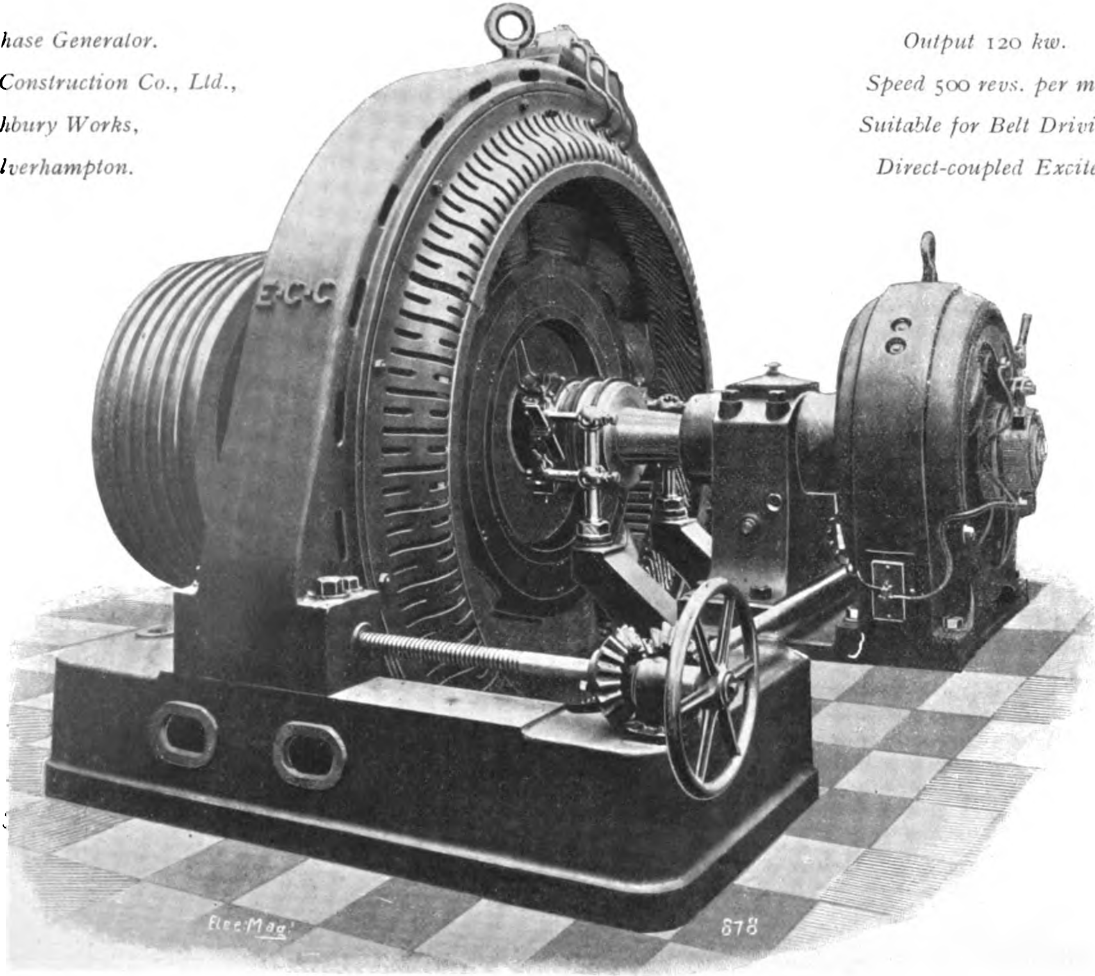
patent automatic joint, and but a glance is needed at these to make the principle at once clear. The "pipe" is divided horizontally and the upper and lower halves can be made to fit so closely that conjointly they form a tube capable of withstanding considerable internal pressure. It will be seen that with a "pipe" so constructed the lower half can be laid in a conduit in the ground, and subsequent to the dropping in of a cable, the upper half can be locked in position and the whole buried with apparently as much confidence as if the conductor had been pulled into a cast-iron pipe or porcelain duct. There would be no risk of damaging the insulation, as the lead would be open to examination while being laid. If the joint will fulfil the demands of everyday practice in the manner claimed by the inventor, the system should meet with an extensive use.



DISTRIBUTING - CONDUIT.

Polyphase Generator.
The Electric Construction Co., Ltd.,
Bushbury Works,
Wolverhampton.

Output 120 kw.
Speed 500 revs. per min.
Suitable for Belt Driving.
Direct-coupled Exciter.



Standard Types of Electrical Apparatus. V.

The World's Electrical Literature Section at end of Magazine contains a classified list of all articles of interest to Central Station men. Consult it and save yourself much valuable time.

"Faults" on Underground Mains: a Remedy.—V.

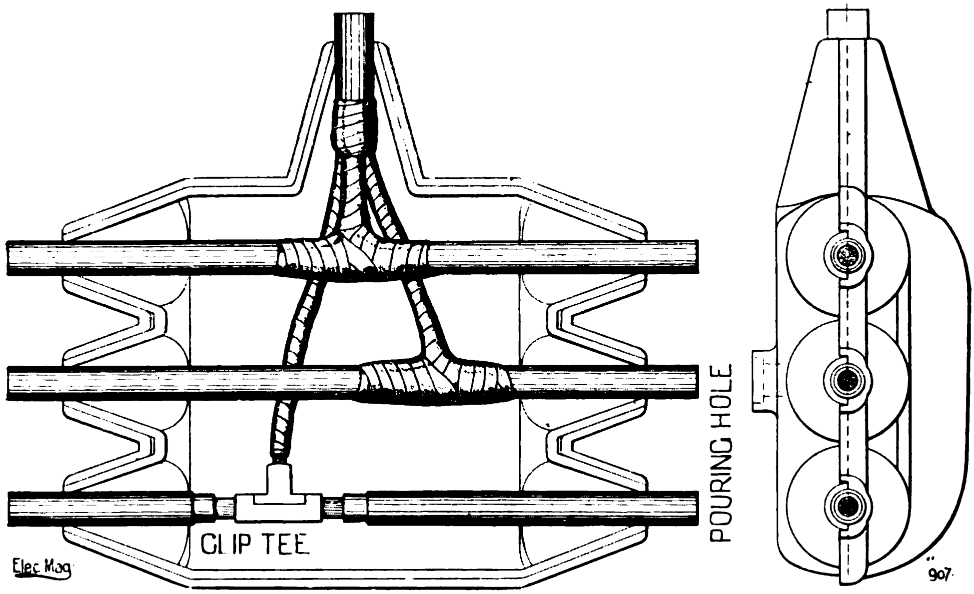
By JAMES CLEARY.

(Concluded from page 412.)

EXPERIENCE has proved that house services account for a large proportion of "faults." There are various reasons for this, and although it is impossible to provide against all contingencies, the number could be reduced considerably if the necessary precautions were taken to prevent them. It is quite a common practice to use house-service cable without first putting it under a pressure test. The usual insulation test is not sufficient. Every drum should be tested well above its working pressure. Great credit is due to the cable manufacturers for the care taken in preparing drums for transit, and generally speaking this is adequate, but sometimes a drum does develop a "fault" *en route*—notwithstanding these precautions—which an insulation test does not detect, and it is necessary to put the extra pressure on to break it down. Then of course there is always the possibility of a flaw in manufacture. Fortunately this is very rare, but that it does happen sometimes can be proved by the records of any station where the pressure test is systematically applied. The few detected in this manner are ample recompense for the extra trouble taken. The most prolific source of faults are the house service joints, and this must continue to be so, as long as engineers are content to use joint-boxes which cannot perform the principal function for which they are made, viz., to keep the joint dry. It is a common fallacy that box-compound will do this, but, good as much of it is, as an insulator there is no mixture made which can withstand the effects of water. It is possible to put on a sufficient quantity of compound to *delay* the trouble, but not *prevent* it.

Some "faults" are due to sharp bends on house-service cable, both inside and outside of building. This should be avoided as there is always a means of overcoming this defect. Great care should also be taken to keep the lead or armour of cables of opposite polarities apart, or from contact with gas or water-pipes, or any "good earth," as the current from one "fault" travelling along the lead often causes another where it sparks to "earth." The risks of this *inside* a building are obvious.

The cost of house-service connections is interesting to all distributing engineers, and any suggestions for economy under this head are always welcome. Their cost is invariably increased by the necessary reinstatement of the various kinds of expensive paving, and although this cannot be avoided altogether it is possible in some cases to reduce it. With this object in view a boring contrivance, which not only saves the cost of reinstatement, but also effects a saving in time, has been invented by a mains engineer. The apparatus is equally efficient in boring under a double tram track, crossing, or side-walk. Unfortunately conditions are not favourable for its use in the centres of large towns, where the presence of large pipes at varying depths would make it prohibitive, but in the suburban districts of most towns where the pipes are few and at reasonable depth, its utility is unquestionable. It can oftentimes be used for boring under paved sidewalks, avoiding all obstructions and inconvenience to the public, the boring can be done quicker than excavating, and the saving per annum effected over the older



method of breaking up side-walk is a distinct gain.

The contrivance consists of a powerful rachet, with forward and backward motion, which travels on a long screw. The drill is especially designed to clear its way through any ordinary obstruction such as loose rubble, gravel, &c., and is capable of pounding a brick. It is screwed on to a length of wrought-iron barrel which forms a socket for it. The other end of the barrel is screwed into a boss on the ratchet which, as it travels on the screw, drives and rotates the drill at the same time. When the ratchet gets to the end of screw it is run back, and another length of barrel joined to the first with an ordinary socket and driven in as before, this operation being repeated until the drill appears at the other end, when it is taken off, and the drilling machine is removed, the iron barrel being left in to pass the house-service cable through. The cost of barrel is more than met by the saving of labour and the consequent saving of time. Add to this the saving of cost of reinstatement it must be admitted that the inventor has gone a long way towards solving a very vexed question. The cost of the machine is trifling compared with its usefulness, and the author has no hesitation in commending it to all engineers interested in the matter. The barrel is worked in, in 3 ft. 6 in. lengths, this being the length of the machine, and it seems to be the most useful length in practice ; it can be worked in shorter lengths if required.

In the case of three single cable distribution it is not necessary to drill three holes, as a lead house-service box has been designed to meet this. *See* illustration. A twin or three-core cable can be jointed on as shown, and the box which is in two halves, afterwards fixed in position, and wiped on to all the cables. This joint is quickly made and is very efficient. The barrel can always be used for renewals or enlargements of service cable.

Where the service is a large one supplying current for motive power, &c., and a constant supply is necessary, it is a good practice to provide against interruption in the case of a "fault" or "short circuit" on the main. This can be done by a duplicate feed through a three-way disconnecting box, the service forming the third way, the mains being fused each way. The fuses blow on the "faulty" main leaving the good one to maintain the supply. The box can be put in side-walk, and if done when the service is being put in the extra cost will not be much, and it will always be useful for testing purposes. Another advantage is that in the event of any emergency the service could be disconnected in a few minutes, whereas if the road had to be opened it could not be done under three or four hours, a delay which might easily lead to serious consequ nces.

In conclusion the author would add that he is prepared to answer any questions concerning matters dealt with in this series of articles.

A correction.—Owing to the substitution of a capital "A" for a small "a" in the last instalment of this article, test No. 2—

pp. 411–412—was not quite in accordance with the author's intention. It should read,

Let D be the length of Main ;

Let a_1 be the cross-section of good cable " ED " ;

Let a_2 be the cross-section of " faulty " cable " BG."

$$\text{Distance from Testing End} = \frac{A_1 V_3 a_2 D}{A_3 V_1 a_1}$$

Notes on the Working of Central Station Plant.—V.

By F. H. CORSON.

(Continued from page 304.)

Steam Consumption and Lubrication.

THE preceding articles have covered the ground where the greater proportion of loss in the generation of power is incurred, and where, consequently, any improvements will show the more marked results. There is, however, great scope for saving or waste in the management of the engine room and auxiliary plant, and unless strict supervision be employed, leakages will occur, which though perhaps small in themselves are nevertheless important and the avoidance of which is of course desirable.

The injudicious running of plant too large for its work and thus low down on the efficiency curve, the use of engines in bad repair, and similar details are instances of this. The lubrication of the plant is a problem requiring the most careful study and one which, it is safe to say, has been thoroughly solved in very few electrical power houses.

The determination of the amount of vacuum which gives the greatest return for the power expended in maintaining it, and the insistence that this, and all other running conditions making for economy shall be observed—these and a score of others are the points at which the station engineer has opportunities of reducing his generator costs, and attention to which will entirely assure his freedom from *ennui*, an affliction sometimes supposed to beset central station men

Regarding first the employment of the plant so as to secure the most efficient generation of power, a rather difficult point is touched upon. Most stations have far outgrown the most sanguine expectations formed at the time of their commencement, with the result that in many cases a considerable amount of small plant has been installed, for which there is no market, and which consequently must be used, at any rate until the undertaking is in a sufficiently strong financial position to be able to write it off the books. This in itself makes the highest economy impossible and the amount of time and money which it is worth while to spend on maintaining such plant must depend on the extent to which it is used.

As was shown in a previous article, the steam pipe and other losses which occur at periods of light load, are so great as to render the steam consumption of the small generating sets used at such times a relatively trivial matter. It is, of course, obvious that the plant which turns out the largest amount of work, demands the first consideration, and that this should be kept in the highest state of efficiency. To this end it is desirable that the more important engines should be frequently and regularly indicated, so as to detect the first departure from correct working, without waiting for more ominous signs of something wrong. Too frequently engines are allowd to run until within measurable distance of breakdown, if this does not actually occur, before any overhauling is done—at the best a haphazard and costly method.

The writer has found it a good plan to set apart one or two days in each month for taking indicator diagrams and to paste these consecutively in a book with notes of any repairs effected during the month. By this means the history of the engines is kept in a very convenient form. These records should be supplemented by frequent removal of cylinder and valve covers to ensure that the internal condition of the engines is satisfactory. The diagrams are usually too small to be of much use in detecting such faults as defective or insufficient lubrication, and gradual increase of wear, until they have reached a stage too advanced to be easily checked. Such examinations become absolutely necessary when the question of selecting lubricants comes up for decision. It is a very common mistake to regard the oil bill as an item by itself, to be reduced to the lowest possible figure, instead of remembering that the repairs account, which is much larger in amount, is to a large extent affected by the suitability or otherwise of the lubricants employed.

As a case in point, the writer has recently overhauled some small 300-kw. high-speed engines, which after twelve months' constant work on a traction load showed only two to four thousandths inch wear on the bearings. At the beginning of this period the lubrication of these sets was very thoroughly investigated, and as the wear has been reduced considerably more than half its previous amount, the time spent on the subject would appear to have been fairly remunerative.

It is a fact not always remembered that most engines possess an " individuality "

of their own, and that two engines exactly similar in design, size, and output, may vary greatly as to friction and amount and quality of lubricant required. This individuality must be ascertained and taken into consideration before the best results can be obtained. The first operation then is to discover on how much, or rather on how little, oil the engine can be run successfully.

With this in view it is advisable to have a log kept for a few days, of the amount of oil used on each of the engines, so as to give a basis on which to work in the later investigations. As cylinder lubrication is by far the more intricate and important branch of the subject, it will be first considered. The opinion still unfortunately prevails in some quarters that almost any thick black oil will do for this purpose, although with the rapid increase in steam pressures, the use of superheat, and the increased demand for efficiency, this view is rapidly dying out.

The oil vendor who rubs his wares in his hand, or employs other physical tests of a no less searching character, as a criterion of their lubricating value, is now becoming more of a tradition than an actuality. That he is not altogether extinct is shown in the fact that within the last few months the writer has several times been gravely informed that black oils are better lubricants than are pale oils, or *vice versâ*, and that an oil which is thick and viscous will have more body in it and give better results in actual work than one which is more fluid. Viscosity and flash-point are frequently quoted and insisted upon, although neither of these qualities appears to have very much to do with the friction-reducing power of lubricants.

In a valuable treatise on *Cylinder Lubrication** recently published, the experiments on a large number of oils of all qualities and prices, conducted at the Liverpool University, prove conclusively that at high temperatures, say 450° F. to 550° F. all oils have practically the same viscosity, which is rather less than that of water at the ordinary temperature.

In the present state of our knowledge of the subject, the actual association of qualities in an oil, which ensures good lubricating power, is not well understood.

The results of the tests above referred to, however, show that the problem is exceedingly complex, and that the specification of the average station engineer, if not quite absurd, is usually very much beside the point. The most suitable oil can only be discovered by a method of trial and error, and the advice and experience of a lubrication specialist, who, to be worthy of the name must be first of all a good mechanical engineer, is here invaluable. At the outset let us select a good oil which from actual knowledge is likely to suit the conditions, and apply it to one of the engines, preferably the one which has given the most trouble in this direction. The feed should be cut down to the lowest amount which will keep the engine running quietly, and free from groaning, a state of things which may, very possibly, not be reached with the first few oils tested. After the first day's work the cylinder and valve covers should be removed, and the valves and valve faces examined. From the results found, useful information will be gained as to whether the distribution of the oil is good, and whether it is likely to resist the temperature of the steam. Slight modifications may be suggested, and the steps repeated until satisfactory work is obtained. Unless the engineer is fortunate, the time and trouble which have been taken to find the right oil will give him a strong disinclination to change it. The lubrication of the other parts of the engine, though much easier, must be determined on similar lines.

Considering the great amount which is at stake, and the disastrous consequences of the employment of unsuitable lubricants, the writer is strongly of the opinion that oil is not a commodity to be included in the annual contract sheet, and determined by a committee on the basis of the pri › gallon or even of a report from an analyst as to viscosity, flash-point, and other considerations which have as little or less to do with lubricating value.

* *Cylinder Lubrication.* By H. M. Wells and W. S. Taggart.

The Introduction of Steam Turbines into Generating Stations.

By a POWER-HOUSE ENGINEER.

For better or for worse, the steam turbine has made its advent into the electric generating stations of this country. Whether or not the innovation is beneficial from the point of view of overall economy under working conditions remains yet to be finally settled. One or two points, however, with regard to the changes which will arise due to its introduction are so patent as to render prophecy more than usually safe. The tendency of late years has been to utilise the advantages of long-distance electric transmission as these have become familiar. Apart from the fact that the advantage of having the generating plant for a large area of supply massed together in one power house under unified control counterbalances the extra expense of laying long-distance high-tension cables and erecting sub-stations at dis-

tributing points, the relative cheapness of land and the absence of vibration complaints have been factors in inducing power supply authorities to place their generating stations at some distance from the distributing area. This is noticeable, for example, in the case of some of the metropolitan supply authorities, who have abandoned the old stations situated in the districts they supplied for newer stations built further away from the haunts of men. That vibration is by no means an inconsiderable factor in influencing the position of the generating station is shown by the fact (which although not of course proclaimed on the house-tops, yet cannot, the writer believes, be denied) that one of our largest municipalities is yearly paying away large sums as compensation to proprietors of property surrounding their generating station on account of vibration.

It is quite possible, however, that the steam turbine will cause the balance of advantage to fall once again to the side of the centrally situated station. The saving of space effected by the use of turbines instead of reciprocating engines is too well known to be further commented upon. Moreover the steam turbine does not give a tithe of the vibration that the older type of prime mover produces.

It is probable that the general introduction of turbines will induce electrical manufacturers to standardise and list machines specially designed for extra-high speeds. That this is not generally the case up to the present is evidenced by the fact that a well-known firm of turbine builders some little time ago evinced considerable reluctance to supply a turbo-dynamo under guarantees unless the dynamo was also built by themselves. This was not a question of price, as the tender of these makers was slightly lower than a provisional quotation made by a firm of dynamo builders of good standing for the same turbine driving their own machine. The turbine builders were aware that electrical contractors had not practically studied the problems of dynamo design as applied to very high speeds as exhaustively as they themselves had, and they did not want to endanger the reputation of their own speciality by combining it with an experimental dynamo. Such monopoly is now, of course, impossible ; but the conditions have still to be studied and met by dynamo builders. The effect of the slightest want of balance in the armature, either at the commencement of running or because of distortion during the application of the high centrifugal forces experienced, would be disastrous. The problem of wedging and binding of the armature sections must be considered afresh ; possibly the mechanical strength of hole-wound armatures will give them a fresh claim. High speeds entail small peripheries, and commutators will be necessarily longer ; means must therefore be standardised for clamping them so as to prevent the bars from bulging, the old method of end-clamping is not sufficient. Owing to the advisability of keeping down the frequency of magnetic cycles in the iron core, and the exigencies of space, the polar fields must be few ; we may see a general return to the almost obsolete two-pole field. The number of coils in the armature are also less, and the volts per coil correspondingly greater. Great attention is therefore to be paid to the insulation of the conductor, and this presents serious difficulties in small machines due to lack of space. Armature cross-ampere-turns cause serious sparking difficulties unless the fields be made extraordinarily strong and the air gaps larger than those to which we are accustomed, because the total current out-put of the machine is less divided among the poles the fewer the number of these poles, causing each particular field to do more work in balancing the cross-magnetising effect of the current-sheet under its influence. The reactance per coil, being now made greater, may cause special devices to be produced for damping out the inductance spark. The influence of potential difference per coil on the insulation of the windings may even determine the limiting voltage of alternating current transmission systems worked by means of turbo-alternators, and in this connection the performance of the turbine-driven machines used for the generation at a pressure of 11,000 volts, of power for the electrification of the London "Underground" railways, will be watched with much interest.

The introduction of the steam turbine may affect the *personnel* of the station staff. A turbine belongs, even more than the high-speed enclosed engine, to the type of automatic machinery that runs with a minimum of skilled supervision. While it is in good condition, a careful fitter-driver can keep it in efficient working order. But if anything does go wrong, the turbine is analogous to the little girl who—

> "When she was good, she was very, very good !
> But when she was bad, she was horrid !"

Once a turbine travelling at the usual high rate of speed develops a hot bearing or fouls anything by its rotors, it requires a cleverer man than the usual engineer to avoid a total smash or to repair it either economically or expeditiously on site. The matter has generally to be referred to the makers. The man who will save the turbo-station will not be the skilled mechanic but the smart synchroniser. The turbine will

probably, then, arrest the present tendency to instal ex-marine engineers as the men in charge of the running plant, for with the departure of reciprocating engines with their array of bearings and oil-drips the particular merits of these men will not be so urgently required. The engineers who will be sought after will be those who, for the same rate of pay, can offer more technical knowledge of the general purpose of the station—the generation of electric power—men who have passed through our electrical factories and whose steam experience has been obtained with the boiler plant actually used in power houses.

INDUSTRIAL SMOKE ANALYSIS.

A CONDITION of prime importance for the economical combustion of fuel is that the right proportion of air should be strictly maintained, and this can only be realised by frequently testing the smoke evolved during the process. A complete analysis is, however, unnecessary, as only the oxidising or reducing nature of the smoke is of interest. M. Le Chatelier pointed out some time ago (*BULL. de La Sté d'Encouragement*, January 1899) that the action of smoke on copper oxide was a good indication of its value as a reducing or oxidising agent, as the oxide and pure metal are very different in aspect, and in consequence he devised a very simple instrument, a description of which will be found in the above-mentioned journal. The apparatus, however, does not give continuous records, and requires tappings of the burnt gases to be taken from the chimney. The inventor has recently shown that another property of the same oxide could be utilised, *i.e.*, its electrical conductivity, which is almost nil in regard to that of pure metal. Observations can then be conducted in the heart of the chimney itself, the only external apparatus required being an electric bell which will ring continuously as long as current is flowing in a circuit containing the reagent. The only difficulty lies in the choice of the conductors and the position and size of the copper mass. The former must evidently not be oxidisable ; platinum or silver will answer the purpose if the system be placed in some part where the temperature lies between 400 and 500° C. The mass should not be voluminous, as this would render the apparatus too sluggish in its indications, and on the other hand, if only a thin metallic plate be used fixed to a non-conducting support, breaks would occur in the circuit and persist even after total reduction of the copper. These difficulties are avoided by using a support made of some porous substance imbibed with a solution of copper nitrate and calcined so as to decompose the nitrate. The final arrangement adopted by the author is the following : Two wires of platinum or silver are permanently fixed side by side and well insulated ; their ends are dipped into a semi-fluid mixture made up of equal parts by weight of asbestos and porcelain or fire clay. This is dried and calcined at red-heat to harden the mixture into a small porous mass connecting the two wires, which is then dipped into a solution containing 10 per cent. of copper nitrate dried and recalcined, this time above red-heat, just sufficiently to decompose the nitrate and blacken the mass. When placed in a very reducing gas-flame, the system should allow current to flow, if not the mass should be again dipped in the nitrate bath to increase the percentage of copper, after which the apparatus is ready for use.

CENTRAL STATION NOTES.

Ageing of Boiler-Plates.

ACCORDING to M. Walther-Meunier, Chief Engineer of the Association Alsacienne des Propriétaires d'Appareils à Vapeur, the average life of boilers should not exceed thirty-five years. The author has completed a series of investigations on the physical condition of old boiler-plates ; 815 test-pieces were taken from a boiler constructed in 1859 by a first-class firm, and which had done constant duty since that epoch. The results of trials with these test-bars showed that the plates were lacking in elasticity and were no longer homogeneous in structure. Now want of elasticity is the chief source of danger in this case, as any small injury which in a sound plate would only lead to partial deformation gives rise in an old plate to fractures liable to cause explosions. Further, it may be said that the replacing of an old boiler affords an opportunity of improving and modernising the stoke-hole.

On the Structure of Magnets.

BOTH the theory of lines of force and the Biot-Savart law admit of two different hypotheses. According to the first hypothesis, the magnet is supposed to rotate, while the field is stationary or else rotates at a different speed. According to the second hypothesis, the Biot-Savart law is applied either to the rotating or to the stationary conductors. Mr. Edmund Hoppe some time ago made experiments by which the field of rotating magnets was shown not to be at rest, it being evidenced that with sufficiently strong fields and a suitable arrangement a displacement of the lines of force (as illustrated by means of iron powder) takes place in the sense of the rotation, resulting in considerable displacement of the distances. It has not yet been ascertained whether the field has the same speed as the rotating magnet, and whether only the viscosity of the medium is responsible for the retardation. Should there be a difference in the speed, the rotating magnet should have on its polar surfaces, an electric polarity opposite to that on the periphery of the central section symmetrical to the axis.

Electrical artisans should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles on subjects of importance to themselves.

Locating Dynamo and Motor Faults.

*By NORMAN G. MEADE.**

SUCCESSFUL "trouble hunting" in dynamo-electric machinery requires considerable skill and a comprehensive knowledge of the principles involved in its design, and it is the purpose of this article to explain briefly some of the defects that are likely to be found in such machinery, and to give a simple and reliable method of finding them. For the sake of simplicity, the accompanying diagrams illustrate bi-polar machines only, but the elements of the design of bi-polar machines are equally applicable to the multi-polar type.

Most trouble in dynamo-electric machinery arise within the armature. The methods of testing for open circuit, short circuit, and ground will now be taken up.

Fig. 1 shows a means of locating a broken lead-wire as at *a*. Clean the brushes and commutator, then apply current from some outside source, say a few cells of battery or a low-pressure dynamo, through an ammeter, as shown in the diagram. Note the current indicated by the ammeter, rotate the armature slowly by hand, and, if the break is in the lead, the flow of current will stop when one brush bears on the segment at fault. The brushes must not cover more than one segment at one time. If, on rotating the armature once around, the deflection of the ammeter does not indicate a broken lead, then touch the terminals of a galvanometer, as in Fig. 2, to adjacent bars, working from bar to bar. The deflection between any two bars should be substantially the same in a perfect armature. If the deflection rises suddenly between two bars, it is indicative of high resistance or a break in the coil, as at *a*. When two adjacent bars are in contact as at *a*, or a coil between two segments becomes short-circuited, as shown in Fig. 3, the bar-to-bar test with galvanometer will detect the fault by showing no deflection. If there is a short circuit between two coils, the galvanometer terminals should include or straddle three commutator bars. The normal deflection will then be twice that indicated between two segments until the coils at fault are reached when the deflection will drop. When this happens, test each coil for trouble; and if individually they are all right, the difficulty is between the two, as shown in Fig. 4 at *a*.

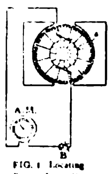


FIG. 1 Locating a Broken Lead Wire

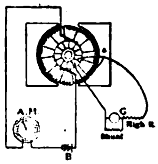


FIG. 2 Locating a Broken Coil

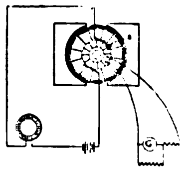


FIG. 3 Locating a Short Circuit between Segments or in Coil

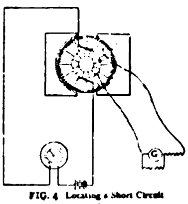


FIG. 4 Locating a Short Circuit between Sections

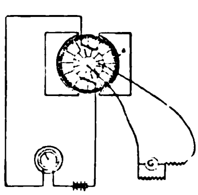


FIG. 5 Locating a Ground

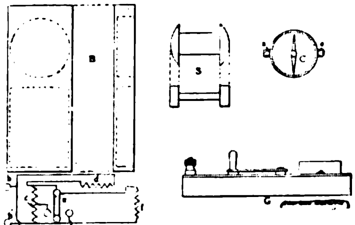


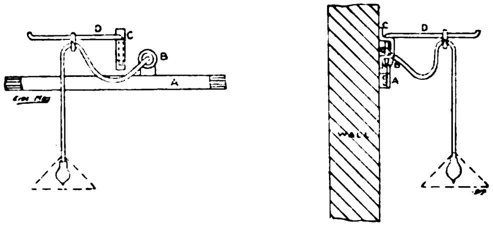
FIG. 6 A Home Made Galvanometer

* *American Machinist.*

A test for ground is given in Fig. 5. Place one terminal of the galvanometer on the shaft or frame of the machine and the other terminal on the commutator. The batteries and instruments used in the test must be throughly insulated from ground. If, under these circumstances, there is any deflection of the galvanometer, it indicates the presence of ground or contact between the armature conductors and the frame of the machine, as at *a*. Move the terminals about the commutator to the point of least deflection, at or near which will be found the contact in the coil connected between two segments showing equal deflection, unless it happens to be close to one segment, in which case there will be a zero deflection. Grounds in the field coils can be located by the same method. The shunt across the galvanometer, and the resistance in series with it, enables the operator to make adjustments whereby the instrument can be used for both high- and low-resistance tests. Fig. 6 shows the details of a "home made" galvanometer, with shunt and resistance. An ordinary compass *C*, with ears *a* and *a'* bored for screws, is attached to a hardwood block *B*. This block is cut out on the under side, as indicated by the dotted lines. A spool of wood *S*, wound with magnet wire to about twenty ohms resistance, is placed in the circular recess under the compass. Two pieces of wood, wound with about fifty ohms each of magnet wire, are placed in the rectangular recess in the block, which is filled with melted paraffin or wax. Mount a three-point switch on the block and provide two binding posts. The finished instrument will appear as at *G*. The connections of the galvanometer are shown at the left of the figure. The binding posts are represented at *b* and *b'*; *c* is the shunt which has a tap at its centre; *d* is the resistance coil, and *f* is the galvanometer coil. The three-point switch enables the operator to cut out one-half of the shunt or the whole of the resistance coil. A combination testing set, consisting of a Wheatstone bridge, chloride-of-silver batteries, and a galvanometer, mounted in a case, is a convenient instrument; but as it is expensive, the ammeter and galvanometer have to be substituted in many cases.

LIGHTING UP FITTING-BENCHES.

The accompanying sketches show a convenient method of lighting up fitting-benches when they run along the side of a wall. The method possesses many advantages over suspending the lamps from the roof as the lamps can be located in the exact position required by the user, this being somewhat difficult when

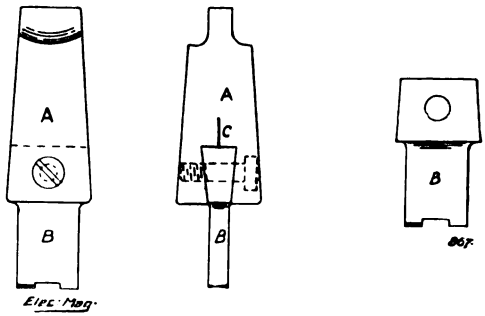


LIGHTING UP FITTING-BENCHES.

they are hung from the roof. In the method here described the wiring is run along the wall about four feet above the benches as shown at A, and taken up to the rose B. C is a wrought-iron bracket fixed on the wall by two screws, drilled to receive the swing arm D, which is made out of ½-in. round iron to the shape shown, a small **S** hook is hung loose on the arm and the wire passed over it as shown. The loop in the lower part of the **S** hook is just large enough for the wire to pass through and keep it the required height when adjusted. —"SWIFT."

SLOT DRILL HOLDER FOR INTERCHANGEABLE CUTTERS.

We have used the cutter holder here shown with success for holding keyway cutters, for sinking keybeds in the middle of shafts, spindles, &c. A is the holder turned to Morse taper with a dovetail slot cut in the end as shown with a sawgrove C cut



SLOT DRILL HOLDER FOR INTERCHANGEABLE CUTTERS.

down the centre for gripping purposes, B is the cutter made out of bar steel with a hole drilled in as shown, the set-screw passing through it as shown and gripping the cutter secure, the cutters being somewhat shorter than when turned with a shank on. There is not as much spring and consequently we take a heavier cut and an increased speed. We use a complete set of cutters from ¼ in. diameter up to 1½ in. diameter in one shank.

ELECTRICAL TRADE and COMMERCE

Trade and Commerce Articles of the month are classified under the World's Electrical Literature Section at end of Magazine.

The Industrial Position in Germany

By W. NOBLE TWELVETREES, M.I.Mech.E., A.M.I.E.E.

At the commencement of the present year industrial activity in Germany was not particularly marked, especially in the iron and steel trades. The formation of the steel syndicate stimulated the iron industry in March, but this was merely temporary, and from April to June its inactivity served to accentuate the unsatisfactory condition of the mining industries. In the first three months of the year, the output of coal and coke was increased, but on account of the mild winter and difficult inland navigation, sales did not keep pace with the production, while coke suffered, in addition, from depression of the iron and steel trades. Coal was further affected by the difficulties experienced by the new "Kohlencontor," or Westphalian coal sales office, which started business on April 1, and met with great opposition. The monopolistic policy of this organisation has created considerable alarm and friction amongst the dealers, who, we are glad to find, are now pushng British in preference to Westphalian coal. In order to secure the accession to the coal syndicate of the coal-mines owned by iron and steel works, it was necessary to give the latter a distinct advantage over the other mines. This has caused another and very serious difficulty to arise within the coal syndicate itself.

Turning now to machinery it may be observed that, while the general position of 1900 has not been recovered, there was a noticeable revival of trade in 1903, and the figures for the first half of the present year indicate that the German machinery trade is regaining lost ground. Although in some instances its hold on foreign markets has been lost, steam-engine, turbines, transmission, and other machinery are being exported in increasing quantities.

Makers of steam-engines are suffering from the increasing adoption of gas-engines and turbines, but locomotive and railway-car builders are well employed. The President of the Association of German Engineering Works has recently advocated a closer organisation of the industry, with the object of improving selling prices, but, bearing in mind the fact that there are about 3,500 engineering works in Germany, it is evident that the amalgamation of the entire industry would present great difficulty.

A very noticeable feature in connection with the electric industry is that the larger firms are well employed; and that the smaller works cannot compete with them in electric lighting, power, and signalling plant, while the manufacture of accumulators is almost completely monopolised by a combination of the largest works. Two groups may now be distinguished in the electric industry, the one producing all classes of electrical goods, and the other manufacturing specialities only. The General Electric, Union Electric, and Siemens-Schukert group gives employment to about 24,000 men, and the other group employs approximately 35,000 workpeople in about 200 manufactories. It ought to be remembered that when the great amalgamations between the leading electrical firms were affected last year, purely financial undertakings were excluded as special companies had already been formed for the purpose of superintending such projects. By this consolidation of the electric industry, the amalgamated businesses have been placed upon a basis which appears to be sound. The majority of the smaller works, which are devoted to specialities, and did not follow the ambitious policy of expansion, weathered the crisis without serious loss, and it is worthy of note that, notwithstanding the vast organisations existing, the number of firms manufacturing special high-class articles has increased considerably in the last few years. Nevertheless, complaints as to low-selling prices still continue to be made. Most of the large towns having been already provided with power stations and electric tramways, this branch of the industry has lost some of its importance. But, on the other hand, the mining industry and agriculture

are becoming good customers, as the use of electricity in both of these industries is increasing rapidly.

ELECTRICAL PROGRESS IN ITALY.

As our readers are aware, the utilisation of electric power in Italy has undergone extraordinary developments since the year 1890. At that time the only important plants were situated at Milan, Rome, Genoa, Turin, and Naples. The oldest installation, that at Milan, had a capacity of only about 2,000 h.p., while the plants at Rome, Genoa, Turin, and Naples, supplied 2,000 h.p., 1,500 h.p., 1,000 h.p., and 3,000 h.p. respectively. The less important plants at Leghorn, Palermo, Syracuse, Terni, Cuneo, Pordenone, Bassano, Treviso, and Alzano-Maggiore, generated together a total motive force of about 10,000 h.p. No statistics are available as to the collective horse-power of the various small plants scattered over the peninsula in 1890, but it is probable that the total electric motive force available in Italy in that year did not exceed 20,000 h.p. To-day electricity in Italy provides a total motive force of over 200,000 h.p. Milan alone disposes of 20,000 h.p., and the large new hydro-electric power station at Vizzola near Milan distributes 18,000 h.p. to various points in the provinces of Milan and Como. Other stations of importance in Lombardy are those of Cakvagese, Varese, and Campodolcino. In Piedmont four plants were erected by the Societa Alta Italia between 1890 and 1901 at Lanzo, Bussoleno, Stambinello, and Germagnano, generating a total force of 12,000 h.p. Other important plants erected since 1890 are those of Cosogno in the province of Novara, and of the Casalese Company in the province of Alessandria. Further, in Lombardy, and Piedmont, especially in the provinces of Turin, Novara, Bergamo, Brescia, and Como, numerous plants have been erected which distribute a total motive force of over 5,000 h.p. The central station at Genoa generates and distributes over 8,000, and those of Rome and Naples over 10,000 h.p. respectively. The new plant at Cellina will shortly be in a position to distribute a motive force of about 18,000 h.p. to the provinces of Udine, Treviso, and Venice. In Umbria two large plants are utilised by local factories in the distribution of over 15,000 h.p. Electric traction in 1890 was only employed on the Florence-Fiesole line ; but to-day, in addition to the complete urban and suburban lines at Milan, Naples, Rome, Genoa, Florence, Leghorn, Palermo, Perugia, and Varese, there are in existence electric lines of Milan-Monza, Milan-Gallarate-Varese, Lecce-Colico, Terni-Collestatte, Lecce-San Cataldo, and some few lines on the Italian Riviera. Altogether some 500 kiloms of railways and tramways in Italy are served by electricity. In 1890 there were about 400 communes in Italy either partially or totally lighted by electricity, while to-day electric light is general in at least 600 communes. From these notes it is evident that the application of electricity to industrial purposes in Italy has shown very marked improvement, and with a continued adaptation of the water-power, with which the country is so richly provided, still greater progress in the same direction will certainly be evidenced in the near future.

ELECTRICITY IN MEXICO. MORE IMPORTANT PROJECTS.

We learn that the present electric plant at Tampico, Mexico, is about to be enlarged and placed under new management. The installation will include a dynamo capable of supplying 4,000 lamps, which together with the equipment already in use, will give a total supply equivalent to nearly 10,000 sixteen-candle-power lamps. New boilers, pumps, and heaters are also to be ordered. Contracts have been made for rewiring the streets and extending the distribution system. A newly organised company has taken over the management of the electric light plant at Mazatlan in Western Mexico, and this company will shortly invite tenders for supplies. The Compania Campechana de Electricidad y Fuerza of Campecha, which was recently organised for the purpose of constructing and operating an electric lighting and power system, is about to let contracts for equipment. Orders have placed for the necessary machinery to operate a hydro-electric power and light plant at Colima, and it is anticipated that the installation of the plant will shortly be commenced. The Conchos River Power Company is about to construct a large water-power electric plant on the Conchos River, Chihuahua. The work contemplated will be of considerable magnitude, and the estimated cost is about £200,000. The power-plant will be located on the Conchos River near the village of La Joya, and energy will be transmitted to Parral, forty-four miles distant, as well as to Chihuahua, eighty miles distant. A series of reservoirs will be built for the purpose of storing the rainfall during the wet season, thus providing against a dry period of any considerable length. The federal government of Mexico has been asked to grant a concession for the construction of an electric railway to connect the mines and the Pacific port of Navidad. It is estimated that the line will be about forty miles long, and will cost over £200,000. Current for operating the railway and the machinery at the

mines will be obtained from power-plants to be erected on two rivers in that section of the state. An American syndicate has applied for permission to construct an electric railway system in Guadalajara, and has offered to pay into the state treasury the sum of £80,000 in eight annual instalments of £10,000 each for the concession. In the event of this offer being accepted by the Government, a bridge will be built over the San Juan River, which flows through the eastern part of the city. The Guanajuato Power and Electric Company is now supplying about one-half of its actual capacity of 64,000 h.p. In spite of the fact that the plant only commenced running about a year ago, it is doing very well, and it is believed that by the end of the year the receipts from the sale of the power will be sufficient to pay all fixed charges, including working expenses and interest. The Mexican Government has granted a concession to construct the necessary works for the utilisation of 2,000 gallons of water per second from the Baluarte River, or from the Rosaria River in the State of Sinoloa. The whole plant is to be finished and in operation within the next five years.

GENERAL TRADE NOTES.

Prospective Business in Brazil.

It is stated that new equipment to the value of about £200,000 will shortly be purchased by the Sao Paulo Light and Power Company, of Sao Paulo, Brazil.

New Electricity Works at Ormskirk.

We learn that the Ormskirk Council will shortly apply for permission to borrow the sum of £15,000 for the erection, equipment, and maintenance of electricity works by the National Electric Construction Company.

Electric Traction for Shanghai.

Tenders for constructing and working an electric traction system in Shanghai are now being invited until March 31, 1905. The length of the proposed route is to be about twenty-four miles. It is stated that Messrs. Fearon, Daniel, and Co., of 96 Wall Street, New York, are interested in this scheme.

Extension of Electric Tramways at Rhos, North Wales.

We are informed that the Rhos Parish Council have now withdrawn their objections to the scheme for extending the electric tramways to Maclor View. Rhos is a popular holiday resort near Ruabon, with a population of about 10,000 persons, and the tramway extension should be a profitable undertaking.

New Wireless Station in France.

A wireless telegraph station will shortly be installed by the French Government on an island off the west coast of France for the purpose of communicating with transatlantic telegraph Experiments made at the Eiffel tower a short time ago, enabled wireless communication to be carried on between Paris and Dijon, a town 200 miles distant.

The First Funicular Electric Railway in Russia.

It is proposed to construct a funicular railway, about sixteen miles long, and which will be operated by electricity, on the line which connects European Russia with Trans-Caucasia. This railway will supersede a mountainous section of the existing Kars line, and, if the project is carried out, will be the first funicular railway constructed in Russia.

Tramway Scheme for West Fife.

A company is about to be formed for the purpose of promoting an extensive tramway scheme for West Fife. This scheme will include the construction of lines: (1) from Dunfermline to Lochgelly; (2) from the junction at Lumphinnans to Oakfield; and (3) from Dunfermline to Inverkeithing *viâ* Hospitalfield. The County Surveyor has been instructed to report on the scheme.

Openings for Trade in Poland.

The French Consul-General at Warsaw points out that there is a good opening in Poland for all kinds of electrical goods, including electric bells, telephone material, incandescent and arc lamps, accumulators, motors, generating machinery, and batteries. At present all these goods are imported from Berlin and Vienna. It is also stated that electric lighting is greatly increasing in this district.

Electric Lighting in West London.

The Kensington Council have refused to cooperate with Willesden in carrying out the electric lighting of the part of Harrow Road in which their respective boundaries are located. The Willesden Council made a similar proposal to the Hammersmith authorities in connection with their part of the road. This suggestion has been accepted, and mains are being laid in this portion of the road for both public and private electric lighting.

Awards at the St. Louis Exhibition.

Electro-Chemistry. — Gold Medal: United Alkali Co., Ltd. Silver Medal: Sherard Cowper-Coles & Co., Ltd. Awards to Collaborators.—Silver Medal: Dr. Andrew Ross Garrick (United Alkali Co., Ltd.).

Electric Lighting. — Gold Medal: The Consolidated Electrical Co., Ltd.; George Trollope & Sons.

Telegraph and Telephony. — Grand Prize. General Post Office, London. Gold Medal: The India Rubber, Gutta-Percha, and Telegraph Works Co., Ltd.; Muirhead & Co.

Various Applications of Electricity. Grand Prize: The Cambridge Scientific Instrument Co., Ltd.; Nalder Bros. & Co. Gold Medal: Nalder Bros. & Thompson, Ltd.; Crompton & Co., Ltd.; Everett, Edgcumbe & Co.; Robert W. Paul; Newton & Co.; Alfred C. Cossor; Elliott Bros.; Kelvin & James White, Ltd.; The Synchronome Co. Silver Medal; F. Darton & Co. Awards to Collaborators. Grand Prize: Lord Kelvin (for important contributions to electrical engineering). Gold

Medal: Hugh Langbourne Callendar, F.R.S. (Cambridge Scientific Instrument Co., Ltd.). William du Bois Duddell, Wh.Sc. (Cambridge Scientific Instrument Co., Ltd.). Silver Medal: Robert Stewart Whipple (Cambridge Scientific Instrument Co., Ltd.). A. C. Heap (Elliott Bros.).

London County Council.

On November 1 the London County Council agreed to make a loan of £11,355 to the Battersea Town Council for electric lighting purposes. The Council also agreed to an expenditure of £22,500, proposed by the Highways Committee, for the conversion of the Northern Tramways to electric traction. Further, the expenditure of £19,280 by the Works Department was authorised in connection with the Streatham car shed, the laying of rails, and the construction of conduits.

Electricity at Lockport, N.Y.

Permission has been granted by the Lockport Council to the Niagara Lockport and Ontario Power Company, to make use of the streets of Lockport in laying mains for the supply of light, heat, and electric power. The concession provides that power shall be generated by water from a canal to be cut from the Niagara River to Lockport. The period allowed for construction is ten years, and it is stipulated that at least £10,000 must be expended on the canal works within the first year.

Asbestos in Finland.

The existence of asbestos in Finland has been known for several years past, but much time has been spent in determining the zone most suitable for its extraction. Among the enormous layers of siliceous magnesia in Finland only a small number of deposits can be taken into consideration for the extraction of asbestos. Of fifteen localities under the control of the Finnish Asbestos Company, not more than three or four deposits have proved really valuable on close examination; but the abundance of asbestos found far exceeds all expectations.

Browett Lindley & Co., Engine Contracts.

This company has recently secured orders aggregating 3,500 b.h.p. for engines, chiefly for electric lighting. They are as follows: From Messrs. Mather and Platt, Ltd., three 200-kw. engines and one 100-kw. engine for the Priddy's Hard Victualling Yard and Royal Forton Barracks to Admiralty specifications; from Messrs. Bruce Peebles and Co., for Canada two engines, each to drive a 250-kw. alternator, these engines also to give a further 50 per cent. overload; from the British Westinghouse Electric and Manufacturing Co., for the Froddingham Iron and Steel Co., one 375-b.h.p. engine. This engine to be capable of giving 100 per cent. overload; from the Cellulose Fabrik Skotselven, Norway, one 40-b.h.p. engine; from Messrs. Steel Bros. and Co., London, for delivery to Rangoon, one 50-b.h.p. engine; from the Union Card Paper Co., Montreal, Canada, one 50-kw. engine; from Messrs. Campbell and Isherwood, Bootle, two 30-b.h.p. engines for ship lighting.

We must also congratulate the company on the acquisition as Managing Director of Mr. F. C. Gibbons, whose old associations with the firm did so much to secure for it a good commercial standing. Mr. Gibbons has our heartiest wishes in his resumption of duties which will, we feel sure, be attended with excellent results.

Developments in Rio de Janeiro.

We understand that electric traction is now employed on all the more important sections of the Rio tramways, and permission has recently been obtained for the construction and operation of a subterranean electric railway between Rio and Nictheroy, on the opposite side of the Rio Bay. A concession has also been granted for the construction of a railway line on the same electric system between Rio and Petropolis. It has recently been stated that the erection of small electric power-plants in the south-western part of the state of Minas Geras might be profitable. Including the great fazendas, there are, in this district, numerous small towns with a population of from 1,000 to 10,000 inhabitants. The electric energy, for the production of which water-power exists in sufficient quantity, could be used for the purpose of lighting the towns, for ice and butter fabrication, for working small machines, and for other purposes.

Electrical Colliery Machinery.

Messrs. Ernest Scott and Mountain, Newcastle-on-Tyne, have recently secured some important orders for electrical colliery plant. Among these we may mention the Mickley Coal Co., two 270-kw. units, two winding gears and one 180-h.p. hauling plant; Lambton Collieries, Ltd., electric pump driven by 66 h.p. motor and 30-h.p. hauling gear; Globe and Phœnix Mining Co., 112-kw. three-phase generator and 40 h.p. three-phase pumping plant, Dunston Swalwell and Garesfield Collieries, Ltd., complete plant, including winding gear, fan, and surface hauling plant, and three throw-pumps in workings; James Ross and Co., Linlithgow, three 200-kw. D.C. units, two 75-h.p. hauling gears and complete surface plant; Messrs. Bell Bros., Ltd., Port Clarence, one 400-kw. unit and one 400-kw. dynamo. In addition, we understand that the company have many orders in hand for extensions to works previously erected.

MEXICAN NOTES.

We understand that negotiations for the acquisition of the present horse-car line in Chihuahua are now completed, and the Mineral Railway, which is worked by steam, has also been acquired. These two lines will be converted to electric traction, and the estimated cost of rails and equipment is about £200,000. A large water power-plant is to be established on the Amacusao River, in the State of Morelos, for supplying current for lighting and general use in the vicinity of Jojulta. The Occidental Construction Co. of Mazatlan, on the Pacific coast, proposes to construct an electric traction system in that town. This company is also interested in a proposal to equip an electric traction system between Mazatlan and Culiacan the capital of the State of Sinaloa.

ELECTRIC FINANCE and Legislation

Local Loans.

By the ASSOCIATE EDITOR.

MUNICIPAL authorities have for some considerable time experienced difficulties in providing the money necessary for the extension of their various undertakings, and lately some of the larger Corporations have had to pay as much as 4 per cent. interest upon the money borrowed. Mr. J. Spencer Phillips, president of the Institute of Bankers, speaking upon this subject, said:

"The debts of our municipal corporations have been increasing, especially during the last ten years, by leaps and bounds. They now amount to £350,000,000, or half the National Debt. The money has been expended, in many cases, on unproductive works, and in others, which I reprobate still more, on municipal trading. Their extravagance has been so great that the money market is now practically closed to them. It is impossible now for a municipality to get out a loan, except at a very usurious rate of interest."

He added that in many cases money was frittered away on objects which certainly should not come under the municipal ken, and mentioned that a Corporation bank was proposed at Huddersfield, while Yarmouth was proposing to run a municipal music hall.

The following extract from the recently issued Report of the Public Loan Commissioners for the past financial year will indicate the gravity of the situation:

"For some years past this Board have felt anxiety on account of the continuing increase in the rates levied in many of the districts for which applications have been made for loans, and during the last financial year they have felt obliged from this cause to refuse, in some cases, applications which have been made to them for loans, and in others to warn the applicants that future applications will probably not be entertained unless a reduction is shown in the rates levied. This Board are under statutory obligation to have regard to the sufficiency of the security for the repayment of their loans; and they consider that in cases where the rates are exceptionally high and there appears to be no probability of any decrease, the security offered is impaired, and that they would not be justified in accepting it as sufficient for a loan of public money."

The fact that local authorities are in this unfortunate position is a serious matter to the country generally, and is adding largely to the depression in trade, because the local authorities, owing to the restriction of capital, are unable to develop, as they would otherwise do, the many important undertakings they own, and this must, in its turn, reduce the orders they place in manufacturers' and contractors' hands.

There can be no doubt that the rate of expenditure upon unproductive works must be checked, particularly in the smaller areas. It is quite easy to see what will happen if the same reckless rate of expenditure is continued. In several towns the rates have already risen to ten shillings in the pound, and if the depression in trade should continue for a considerable time, the rates must go up enormously, as the producing power of the rate will be reduced owing to the empty property and the inability of those out of work to pay. This will certainly cause all those who can possibly leave the district to do so, and those remaining will be compelled to seek the aid of Parliament to extend the period allowed for the repayment of loans, and thus reduce the annual amount required. This will mean that such district will be in the next generation paying for undertakings which very probably will have passed out of existence.

The town councillor must be forced to understand that a town is subject to depression, and that provision must be made to meet such depression. Oldham is an illustration; owing to the speculating in cotton and its consequent dearness, the mills were forced to reduce the running hours; unfortunately this has continued for many months, and the operatives are in a

very sad condition, and have been compelled to leave their homes, and are now living in some cases three and four families in a house. A very large number of houses are empty, and unless things improve quickly Oldham will be in a very serious condition. It is obvious that a depression of this kind must also place all trading undertakings, such as Gas, Electricity, and Trams, in a correspondingly serious condition, because the revenue must in all cases be reduced, and consequently the profits decreased or the losses increased. This again brings the burden back with increased weight upon the ratepayers, unless substantial reserve funds are available.

We think local authorities are placing themselves at a great disadvantage by arranging to borrow upon the present generally adopted system of repaying by yearly instalments of principal and interest. Such terms of repayment are not generally understood by the investing public, who would much prefer a mortgage repayable at the end of a fixed term of years; and it is, we think, the peculiar methods adopted by municipalities which have tended to increase their difficulties, as they have been forced to borrow from Banks and Insurance Companies, who are able to re-invest the proportion of the loan returned each year, and who naturally find themselves in the happy position of being able to regulate to some extent the rate of interest.

We notice the Borough of Islington is requiring the sum of £33,000 for its electric lighting business, and proposes to borrow the money by issuing short term mortgages, instead of following the usual course of applying to the London County Council, and we anticipate that the money will soon be forthcoming if raised in this manner. There is another advantage in connection with these short term mortgages, which should lead to their more general adoption; that is the fact that the amount of money provided yearly by the undertaking for the repayment of capital can be actually repaid, and will not require re-investment by the local authority.

Electrical Poaching.

The Electric Lighting Acts have provided many interesting cases in the past, no doubt due to the fact that it is exceedingly difficult to make laws to anticipate the ever increasing and varying requirements of the electrical industry; and the judgment delivered by Mr. Justice Farwell in the case of the Attorney-General and others *v.* the Metropolitan Electric Supply Co. is of special interest to those connected with supply undertaking. The Metropolitan Electric Supply Company were allotted certain supply areas in London under their Act of 1889 and subsequent Provisional Orders. The Act and the Provisional Orders all contain the clause, subsequently embodied in the Electric Lighting (Clauses) Act, to the effect that the undertakers should not, after the commencement of the Order, "supply energy or (except for the purposes of the Order) lay down electric lines or works beyond the area of supply," except with the sanction of Parliament or under a Board of Trade Licence under the Electric Lighting Act.

In 1898 the Company found it necessary to obtain Parliamentary sanction to supply the areas for which powers had already been obtained from an external generating station. The works at Willesden were completed, and at the end of last year the Company commenced supplying energy to the London and North-Western Railway Co., whose sidings adjoin the works. The Urban District Council of Willesden had in the meantime commenced an electric supply in their own district, and considered that the London and North Western Railway Co. should buy its electrical energy from them, as they were the only Authority in the district possessing statutory powers to supply them.

The Metropolitan Electric Supply Co. considered that they had a right to do this under their articles of association; but the District Council contended that under the terms of the Provisional Orders, the Acts already referred to, this particular company's area of supply was limited to the metropolitan areas. Mr. Justice Farwell has upheld this point of view, and has granted an injunction against the Company. We do not see how any other conclusion could have been arrived at, and shall fully expect to hear this decision upheld upon appeal. It would be a most serious thing for the electric supply industry if Companies were allowed to poach upon each other's territory; and the point appears to have been carefully studied by the House of Lords, who have decided in the case of gas that the point at which the gas is consumed is the point of supply, not the position of the meter. It should not be assumed that a Provisional Order gives a monopoly. Any person or company can undertake to supply any premises without obtaining a Provisional Order, but without this statutory authority they are unable to lay mains under or along streets without the consent of the local authority. The only case we know of where two companies are supplying in competition is in the City of London, and it will be remembered that when the City authorities allowed another Company to enter the area of supply of the City

Company a great outcry was raised against the authorities, and it was held to be wrong to depart from an agreement which had practically led to the formation of the City Company. We are strongly of opinion that the areas allotted by Parliament should be strictly confined to the operations of the one Company or local authority who obtain such powers, and we are surprised to find those who condemned the City authorities now supporting the views of the Metropolitan Electric Supply Company. Possibly such opinions are influenced by the fact that in this case it is a Company trying to obtain an advantage over a local authority.

GENERAL FINANCE NOTES.

York.

THE income of the Corporation's electric supply undertaking for the year ended March 31 last amounted to £9,113, and the income to £4,963, leaving a gross profit of £4,150. Interest and sinking-fund charges amounted to £3,799, the net surplus remaining being £351. This surplus is to be transferred to reserve fund. The number of units sold during the year was 766,542,.

Public Acetylene Lighting in the United Kingdom.

FROM the *Ironmonger* we gather that some sixteen towns and villages have adopted public acetylene supply for street and private lighting. These comprise Aberfoyle, Arklow, Craven Arms, Dunfanaghy, Edarclerry, Gost, Hawes, Hillesley, Hunmanby, Lee-on-Solent, Nenagh, Rootoy, St. Michaels, Tandragee, West Swinton and Wilhorn; and an average price for the gas appears to be 55*s.* 3*d.* per 1,000 ft., or about 5*s.* 7*d.* per 100 ft., which, it is noted, compares very favourably with the averages obtained in German towns similarly lighted.

Belfast Returns.

THE returns of the Belfast Electric Supply undertaking for the year ending March 31, 1904, are exceedingly satisfactory, and are considerably better than the returns for the previous year. The financial results are as follows:

Financial Results.

	1903–1904.	1902–1903.
Capital expenditure at end of year	£230,265	£217,124
Total revenue	£27,401	£22,504
Total costs	£9,877	£9,155
Gross profit	£17,524	£13,349
Percentage of gross profit to average capital	7.83%	6.30%
Interest on loans, less interest receivable	£6,794	£6,230
Sinking-fund	£4,636	£4,517
Financial result, after providing for interest and sinking-fund: surplus	£6,094	£2,602

Norwich Electric Tramways Company, Ltd.

THE report of the Norwich Electric Tramways Company for the year ended June 30 last states that the earnings show an increase over those of the pevious year, traffic receipts having amounted to £34,720, against £33,516 in 1903. The result of the year's working is a gross profit of £10,768, to which has to be added £201 interest received and £1,213 brought forward. Deducting from this £2,640, being 4 per cent. interest to June 30, 1904, on the outstanding mortgage debentures, and £1,012, which the directors have placed to reserve account, there remains a profit of £8,529. The directors recommend that a dividend of 3 per cent. be paid on the shares for the year, leaving £609 to be carried forward. The reserve will then stand at £3,197. The operating expenses for the year show an increase of £85. The number of passengers carried was 7,461,718, and the number of car miles run was 1,088,951.

Western Telegraph Company, Ltd.

THE revenue for the half-year ended June 30 amounted to £241,981, and the working expenses to £99,547. After providing £13,868 for debenture stock and debenture interest and sinking-fund, and £5,893 for income-tax, there remains a balance of £122,672; to this is added the sum of £4,939 brought from December last, making a total of £127,611. The revenue includes £17,114 dividends upon the company's investments in other telegraph companies, and £7,322 interest on reserve fund investments. A quarterly interim dividend of £31,189 has been paid, £22,000 transferred to the general reserve fund, and £18,000 to the maintenance ships reserve fund. The directors now recommend the declaration of a final dividend of 3*s.* per share, making, with the interim dividends, a total dividend of 6 per cent for the year, and also the payment of a bonus of 2*s.* per share, both free of income-tax, which, together, will amount to £51,982, leaving a balance of £4,439 to be carried forward.

Portsmouth.

AT the last meeting the Town Council began by sanctioning an application to the Local Government Board for leave to borrow £1,200 to complete the proposed telephone extensions to Southsea, this sum being in addition to the £635 already decided on by the Council. The next business was larger in amount—namely, to consider the recommendation of the Telephone Committee that an application be made to the Local Government Board for leave to borrow £20,000 to cover future extensions of the telephone system. The estimate is for 1,000 lines at £20 per line, and this is exclusive of the extension to Southsea. This amount of work, however, is not to be done at once; the purpose of the application is to enable extensions to be made when decided on by the Council, without having to wait on each occasion for a separate order from the Local Government Board. It was stated, as regards the necessity of the matter, that orders were coming in on an average of ten a week, without any undue pressure or advertising, and the Telephone Committee anticipated exhausting the money in two years. The Council therefore adopted the Committee's recommendation.

Rosario Electric Company.

THE report for the year ended June 30 last states that the balance at credit of profit and loss account, including the balance brought forward, amounts to £6,500. The directors recommend that £480 be applied to amortisation

of concessional rights, writing off for depreciation of tools and stores, and buildings, plant, and machinery, £1,506. After paying a dividend of 6 per cent. on the preference shares, there remains to be carried forward £913. The new station and network were handed over by the contractors to the company in August 1903. Various extensions of the underground mains have been made during the year, and the transfer of private consumers from the old to the new system is practically complete. At June 30, 1904 (including theatres—about 11,300 lamps), there were 43,749 consumers connected. Credits for lighting and power for the six months to December 31, 1903, were: Public, £4,404; private, £7,098; for the six months to June 30, 1904, the figures were: Public, £4,446; private, £9,600. For the two months July and August, 1904, the gross receipts were £5,880, as against £4,060 in the previous year, and the net receipts £2,450, against £840. In view of the rapid growth of demand for lighting and power the directors have placed an order for an additional 500-kw. set. To provide for new plant and for further remunerative extensions, the shareholders will be asked to authorise the issue of 8,000 additional preference shares of £5 each.

Sheffield.

The financial results of the Sheffield Corporation Electric Supply undertaking for the year ending March 25, 1904, show considerable improvement in the revenue, and a satisfactory reduction in the works costs per unit sold, but the results are not by any means what they should be. The balance is less than the previous year, and the amount provided for the redemption of capital is altogether too small to keep the undertaking in a sound condition, because the capital contains a quantity of "water" owing to the fact that in 1892 the undertaking was purchased from a company at more than double its cost price, and very considerable alterations have been made which must have necessitated the scrapping of part, at any rate, of the plant purchased from the company. Special provisions should be made for depreciation or the capital should be reduced, and we shall hope to see next year that this has been done. The undertaking is not supplying energy for the tramways or public lighting, and consequently very flourishing returns cannot be expected.

Financial results.	1903-4.	1902-3.
Capital expended	£740,943	£616,994
Total revenue	£57,100	£47,200
Total costs	£17,458	£15,754
Gross profit	£39,642	£31,446
Percentage of gross profit to capital	5.84	5.44
Interest on loans	£22,608	£18,851
Sinking-fund	£11,604	£6,061
Surplus	£5,430	£6,534

County Electric Power Schemes.

A CONFERENCE was held in the Miners' Hall, Durham, to consider the advisability of promoting a scheme for supplying electric power to the County of Durham, and a resolution was adopted urging local bodies to withhold their support from any private scheme pending the development of a public scheme. It would seem that the meeting did not realise the fact that the area is already covered by a power company actually in operation, but there are many counties where the County Council could be of great assistance. The Electric Lighting Acts are so framed that a Parish Council cannot borrow the money necessary to establish electrical installations, although there are a vast number of such places where no gas is available, and where electricity, supplied either from a small parish installation or from works constructed for the purpose of supplying several adjacent parishes, would be a public benefit.

Richardsons, Westgarth and Company.

At the meeting of this company held at Hartlepool, a dividend of 6 per cent. per annum on the ordinary shares was approved, and in the course of his speech the chairman (Sir Christopher Furness) had a good deal to say about the steps which are being taken to enable the company to keep abreast of the times. They had spent £50,000 on the new turbine works and other extensions, and their turbine shops embodied all the latest improvements for accurate production and the comfort of the employees. To obtain maximum efficiency from steam turbines, the very highest class of workmanship was imperative; the machine tools must be the best obtain able, and in their shops the leading makers in this country, America, Germany, and Switzerland were represented. It was their intention to maintain this high standard, being convinced that electrical engineers would appreciate the fact that maximum economy of working and the greatest freedom from accidents could only result from excellence of material and accuracy of manufacture. They had already despatched three installations for mines in Australia, and had in progress contracts for various parts of the world. They had under test a 750-kw. set running at 2,300 r.p.m., which was of special interest from the fact that the generators were continuous current of a patent compensated type, giving sparkless running notwithstanding the extremely high speed. Another set under test was a 400-kw. three-phase alternator, which was part of the equipment of a power installation for a gold-mine in Australia, whilst another set of 3,000 h.p. was for the Hammersmith Corporation. From the number of inquiries received from mining engineers, it was evident that they appreciated the fact that steam turbines were eminently suitable for power installations in mines. The demands on the turbine department had necessitated additions to their iron foundry, and they were also building a new brass foundry. Another manufacture which promised well in the future was that of water-tube boilers for land purposes. After careful investigation they decided to adopt the Hornsby boiler for their turbine-testing plant, and the results had been so satisfactory that they had arranged for a licence, and had already commenced the manufacture at Middlesbrough. They had also become manufacturers of Messrs. Easton and Anderson's pumping machinery and other specialities. At Middlesbrough they were making a speciality of work in connection with steel plants, including both steam and gas-driven blowing-engines, blast-furnace, gas-cleaners, Talbot furnaces, converters, mixer vessels and rolling-mill plants.

New Electrical Patents

Selected Specifications.

*By E. de PASS, F.Ch. Inst., P.A.,
78 Fleet Street, E.C.*

"Joints on Metal Plates, Pipes, &c."

(No. 17372. Dated August 7, 1902. G. Wyndham Edwards) (*see* Manufacturing Section).

Claims.—(1) The formation, by bending or otherwise moulding the edges of a metal plate, of a tapered male or spigot edge on one or more sides of the said metal plate, and the formation of a correspondingly tapered female or socket edge on the relatively opposite side, or sides, of the plate.

(2) The formation of an automatic interlocking arrangement, by cutting and otherwise treating sundry portions of the newly turned edges of the said plate, so that when the male edge of one plate is pressed into the female of the other they interlock and are fixed.

(3) A releasing arrangement formed by piercing the plate, in a suitable position, of the female socket forming the interlocking part, and the adoption of a tapered drift or tool for the purpose of release.

"Dynamo Electric Machines for Regulating the Charge and Discharge of Storage Batteries used in Combination with Main Generators."

(No. 15811. Dated July 17, 1903. The Lancashire Dynamo and Motor Company, Limited, and Robert Stafford McLeod, both of Manchester.)

This invention relates to dynamo electric machines for regulating the charge and discharge of storage batteries, and comprises a reversible booster connected in series with the battery across the mains, a motor for driving the booster, and field magnet windings (and if necessary an exciter therefor), on the booster adapted to provide a field excitation such as to give at the booster terminals a voltage of such value and sign as may be necessary to enable the battery to discharge when the external load is greater than the normal output of the main generator, and to charge when the said load is less than the said output. In this way the booster serves to so regulate the battery as to tend to maintain a constant main generator output with a varying load.

Claims.—(1) In apparatus such as herein described, in combination with the generating means and the battery: an exciter, on the field of which are two windings with magnetising effects respectively proportional to the voltage and to the current, and a booster the armature of which is connected in series with the battery between the mains, and on the field of which are two windings with magnetising effects respectively proportional to the exciter voltage and to the difference of voltage between the battery and the mains.

(2) In apparatus such as herein described, in combination with the generating means and the battery: an exciter, on the field of which are two windings with magnetising effects respectively proportional to the voltage and to the current, and a booster the armature of which is connected in series with the battery between the mains, and on the field of which are three windings with magnetising effects respectively proportional to the exciter voltage, to the difference of voltage between the battery and the mains, and to the battery current.

(3) In apparatus such as herein described, in combination with the generating means and the battery: an exciter, on the field of which are three windings with magnetising effects respectively proportional to the voltage, to the current, and to the battery current, and a booster the armature of which is connected in series with the battery between the mains, and on the field of which are two windings with magnetising effects respectively proportional to the exciter voltage and to the difference of voltage between the battery and the mains.

(4) In apparatus such as herein described, in combination with the generating means and the battery: an exciter, on the field

of which are two windings with magnetising effects respectively proportional to the voltage and to the current, and a booster the armature of which is connected in series with the battery between the mains, and on the fields of which are three windings with magnetising effects proportional respectively to the exciter voltage, to the main voltage, and to the battery voltage.

(5) In apparatus such as herein described, in combination with the generating means and the battery: an exciter, on the field of which are two windings with magnetising effects respectively proportional to the voltage and to the current, and a booster the armature of which is connected in series with the battery between the mains, and on the fields of which are four windings with magnetising effects proportional respectively to the exciter voltage, to the main voltage, to the battery voltage, and to the current in the battery.

(6) In apparatus such as herein described, in combination with the generating means and the battery: an exciter, on the field of which are three windings with magnetising effects respectively proportional to the voltage, to the current, and to the battery current, and a booster the armature of which is connected in series with the battery between the mains, and on the fields of which are three windings with magnetising effects proportional respectively to the exciter voltage, to the main voltage, and to the battery voltage.

(7) In apparatus such as herein described, in combination with the generating means and the battery: an exciter, on the field of which are three windings with magnetising effects respectively proportional to the voltage, to the current, and to the difference of voltage between the battery and the mains, and a booster the armature of which is connected in series with the battery between the mains and on the field of which is a winding with a magnetising effect proportional to the exciter voltage.

(8) In apparatus such as herein described, in combination with the generating means and the battery: an exciter, on the field of which are three windings with magnetising effects respectively proportional to the voltage, to the current and to the difference of voltage between the battery and the mains, and a booster the armature of which is connected in series with the battery between the mains and on the field of which there are two windings with magnetising effects proportional respectively to the exciter voltage and to the battery current.

(9) In apparatus such as herein described, in combination with the generating means and the battery: an exciter, on the field of which are four windings with magnetising effects respectively proportional to the voltage, to the current, to the difference of voltage between the battery and the mains, and to the battery current, and a booster the armature of which is connected in series with a battery between the mains and on the field of which is a winding with a magnetising effect proportional to the exciter voltage.

(10) In apparatus such as herein described, in combination with the generating means and the battery: a booster, the armature of which is connected in series with the battery between the mains and on the field of which are two windings the magnetising effects of which are proportional respectively to the voltage, and to the current, and two windings the joint magnetising effect of which is proportional to the difference in voltage between the battery and the mains.

(11) In apparatus such as herein described, in combination with the generating means and the battery: a booster, the armature of which is connected in series with the battery between the mains and on the field of which are two windings the magnetising effects of which are proportional respectively to the voltage, and to the current, and two windings the joint magnetising effect of which is proportional to the difference in voltage between the battery and the mains; and a fifth winding the magnetising effect of which is proportional to the battery current.

(12) In apparatus such as herein described, in combination with the generating means and the battery: a booster, the armature of which is connected in series with the battery between the mains and on the field of which are two windings the magnetising effects of which are proportional respectively to the voltage, and to the current, and a winding the magnetising effect of which is proportional to the battery voltage.

(13) In apparatus such as herein described, in combination with the generating means and the battery: a booster, the armature of which is connected in series with the battery between the mains, and on the field of which are four windings the magnetising effects of which are proportional respectively to the voltage, the current, the voltage of the battery, and the battery current.

"Means for Breaking Electric Circuits."

(No. 16360. Dated July 24, 1903. Carl Bennett Auel and John Rudolph Spurrier, both of Manchester.)

This invention relates to means for breaking electric circuits, and has for its object to construct an improved device of this kind, in which a fuse is combined with a switch which is automatically operated when the fuse melts so that the length of the fuse

can be diminished and the danger of damage to the terminals of the fuse is reduced to a minimum.

Claims.—(1) A circuit-breaking device consisting of a fuse surrounded by a gaseous medium combined with a switch the contacts of which are located in an insulating liquid in such a manner that, when the fuse melts the switch will be automatically brought into operation and cause the final rupture of the circuit.

(2) Circuit-breaking devices constructed and operating as described.

"A Construction of Electric Railway and Vehicles for Transporting Letters and other Light Loads at High Speeds."

(No. 16583. Dated July 28, 1903. Dimitri Monnier of Paris.)

This invention relates to the construction of a railway and vehicles for the electrical transport of letters, light parcels, and the like, whereby a speed of at least 250 kilometres per hour under good practical conditions can be attained.

The invention comprises both the construction of the railway or conduit and of the vehicles for the transport.

Claims.—(1) Railway and apparatus for the transport of light loads, consisting firstly of one or more lines of rail contained in a closed conduit tunnel or tube, each line consisting of a single running rail and an upper guide rail, the supports of such rails being constituted by surfaces of revolution whose central axis coincides with the centre of gravity of the vehicle, and secondly of a vehicle body mounted on springs upon the axles of two running wheels each of which is driven through the medium of belts from an electric motor suspended from the framing by pivoted beams.

(2) In transporting apparatus such as is referred to in the first claim, the arrangement of the electro motors that drive the running wheels with a central stator suspended from beams pivoted to the casing and a rotor the outer casing of which constitutes two pulleys that drive by means of belts corresponding pulleys on the axle of the running wheels, the required tension of the belts being effected by springs acting on the motor so as to tend to draw it away from the wheel axle.

(3) In transporting apparatus such as is referred to in the first claim, the putting in action of the mechanical brakes by causing the interruption of an electric current to effect the opening of a valve so as to allow fluid pressure to pass to the brake cylinders.

(4) In transporting apparatus such as is referred to in the first and third claims, the combination with a brake cylinder and a reservoir for supplying the same with fluid pressure of a valve which is automatically opened by a lever acted upon by a fixed incline situated at the commencement of the section where the braking has to be effected, and a second valve on the same conduit as the first one, which second valve is arranged to be opened at will by the interruption of an electric current.

(5) In transporting apparatus such as is referred to in the first claim, the combination with pivoted wings or shutters which are normally closed, of cylinders with pistons into which fluid pressure is admitted on the opening of the valve that controls the brakes, so as to effect the opening out of the wings or shutters in order thereby to increase the resistance offered by the air to the passage of the vehicle.

"Induction Transformer for Wireless Telegraphy Stations."

(No. 17034. Dated August 5, 1903. Eugène Ducretet of Paris.)

This invention relates to wireless telegraph receiving systems and more particularly to a novel oscillation transformer to be used in connection therewith.

The transformer comprises essentially two superposed spirals and assures the regulation of the receiver according to the distances between the stations and the amount of energy transmitted by Hertzian waves. With this transformer any known form of coherer may be used in connection with a relay and usual Morse register, or other equivalent means; or the Popoff receiver (which consists of a telephone receiver connected, without the interposition of a relay, to the terminals of two carbon electrodes bridged by steel needles) may be used.

Claims.—(1) In a wireless telegraph receiving system, an oscillation transformer whose primary and secondary windings consist of flat spirals superposed one on the other, and means for making electrical connection with various parts of each spiral, whereby the number of effective turns is varied.

(2) In a wireless telegraph receiving system, an oscillation transformer whose primary and secondary windings consist of parallel flat spirals.

(3) In a wireless telegraph receiving system, an ærial conductor, a flat spiral connected in series therewith, a second flat spiral inductively associated with the first-mentioned spiral and a receiver connected with the second spiral.

(4) In a wireless telegraph receiving system, an ærial conductor, a flat spiral connected in series therewith, a second flat spiral parallel to the first. and a receiver connected with the second spiral.

"Workshop Costs for Engineers and Manufacturers."

By SINCLAIR PEARN and FRANK PEARN The Technical Publishing Co., Ltd., Deansgate, Manchester. Price 21s. net.

It has been said that a good engineer must not only be able to make good engines but also to make money, and though this statement, like all generalisations must be received with caution, it will be found to contain more than a little truth. The successful management of an engineering works depends upon producing the best possible article at the lowest possible cost, and it is the aim of every manager to combine these two conditions. The production of good workmanship is the more attractive side of the question, and as such has always received its fair share of attention, but no amount of excellence in either design or workmanship will avail if the article can only be sold at a prohibitive price. The first step towards cheapening the cost of production is to know the exact cost of every process of manufacture. The systems of cost-keeping in most shops are generally far behind other details of the management, and though the old-fashioned manager will maintain that it is better to have a vague idea as to how a sovereign was earned than to have an exact knowledge how one was lost, it is very certain that a simple and accurate system of cost-keeping will have the most beneficial effect on the profits. Very few systems, we venture to say, so far combine simplicity with efficacy as the one advocated in the present book. It has been evolved to meet the needs of an actual manufacturing establishment and so successful has it proved that it is now published as a practical way of solving the problem of accurately and easily keeping the costs of manufacturing operations. The system is illustrated by examples of its application to the productions of Messrs. Frank Pearn and Co.,Gorton, namely, pumping machinery. The book has been divided into five parts, dealing in turn with the Registration of Patterns and Materials. The recording and Analysis of Labour Standard or Repetition Work Stores and Assembly Work, and Contract or Special Work.

It would occupy too much space even to summarise here the details of the system which, moreover, could not be made clear without reproducing the official forms by which the clerical work is carried out. These are kept to the minimum number, consistent with the objects in view, and are so arranged that by a sort of "double entry" any error by either the workman or the time clerk is at once noticed in the cost department. Detail bookings of work done on pieces are posted daily on the cost sheets relating to the particular jobs, so that these sheets accurately represent both the progress made and the cost up to date of any job going through the shops. The advantage to the manager of being able to instantly find out without questioning or assistance, the exact condition of any job will be readily appreciated, and he can even learn from the sheet in what part of the shops any detail is likely to be found by noting what operation it is undergoing at the time. The book contains a complete set of official forms necessary to the system, the forms in many cases being filled in to render their use clearer, and the publishers have made arrangements with professional accountants to give assistance to any manufacturers desiring to initiate this system or any modification of it in their own works.

"Dynamo Motor and Switchboard Circuits."

By W. R. BOWKER. London: Crosby Lockwood and Son, Ludgate Hill, E.C.

Into this book a mass of information in the shape of diagrams of connections has been packed after collection from a variety of sources. As a record of these diagrams it may find a sphere of utility among students. The motor connections might well have been supplemented with diagrams of multiple-unit train control systems and also of the multi-voltage methods of motor control for workshops and printing machinery. The book contains a quantity of superfluous matter which might well have given place to more valuable and more modern information.

"The Management of Electric Tramways and Light Railways."

By W. R. BOWKER. London: E. F. W. Spon, Ltd., 125 Strand, W.C. Price 9s.

A glance at the preface of this book warns the reviewer that its contents are chiefly excerpts from published articles by well-known authorities on the subjects dealt with. The reader will have little difficulty in discriminating between these abstracts and the effusions of the "author" as the "style" of the latter is distinguishable sometimes painfully so, throughout the book. Still as a collection of much valuable matter from undisputed sources of authority, we commend it to tramway managers and their assistants generally.

The leading contents of the periodical electrical press of the world, papers read before Learned Societies, and any other literature treating upon electrical subjects are arranged *under subject-matter* in this section. Suitable references are made to the names and dates of the various papers, and the whole forms an index guide of considerable importance and value.

Power.

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Lightning-Arresters for High-Tension Plants. B. Börner.	*Elek. Anzg.* 3/11/04.

Papers.

•Steam Economics in Small Central Stations. J. A. Allen.	*Michigan Elec. Assoc.* 12/10/04.

Articles marked with an asterisk are of exceptional interest, and well worth reading. Copies of any article or paper can be obtained on application to this office, a nominal fee only being charged for the clerical time occupied in taking out same. If desired, the whole publication will be procured (same not being out of print) on payment of the published price.

Where foreign papers have a similar title to those published in this country, the initial letters of the place of publication will be inserted after the abbreviated name of the particular paper; for instance, the English Electrical Review will be abbreviated Elec. Rev., and the American Electrical Review, Elec. Rev. N.Y.

New Catalogues.

POWER.

Motors.—THE BRITISH THOMSON-HOUSTON CO., LTD., Rugby. Pamphlet No. 175, of which a copy has just reached us, deals with two- and three-phase induction motors. These are made squirrel-cage rotor and also with slip-rings, according to the size required. The list deals with machines from $\frac{1}{4}$ h.p. to 300 h.p. For 40, 50, and 60 cycles and pressure from 100 to 5000 volts.

THE LAHMEYER ELECTRICAL CO., LTD., 109–111 New Oxford Street, W.C. We have just received list No. 27 giving details of the Company's single-phase motors for a heavy starting torque. The pamphlet is illustrated with diagrams and efficiency curves. The motor is of the commutator type with slip-rings at one end of the shaft and commutator at the other. Sizes up to 8 h.p. are fitted with ball bearings.

CROMPTON AND CO., LTD., Salisbury House, London Wall, E.C. A substantial pamphlet dealing with this Company's continuous motors has been recently issued. This goes into full details of the various standard types manufactured. The publication is a splendid example of what can be done in the way of standardising this class of electrical apparatus. To find the price of the machine required is an extremely simple matter, as standard rates have been fixed irrespective of output or voltage within a certain range. The complex tables issued by many manufacturers are conspicuous by their absence from this list, and we should anticipate an increase of business on this account alone. After all, the essence of success in manufacturing is not only the production of a high-class article, but the adoption of the best means of placing this before a customer. In addition to the usual range of standard motors, special types for crane work and slow speeds are listed.

THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING CO., LTD., London and Manchester. Circular B 1,071 treats of type "S.B." direct-current motors, made in sizes for $\frac{3}{4}$ to 100 h.p. and pressures from 110–500 volts. The list details the construction of these motors and is concluded with a number of tables setting forth sizes, rating, frame particulars, &c., but no prices are given. The circular is well printed and is got up in the Company's usual good style.

Power Tools.—J. BUTLER and Co., Victoria Iron Works, Halifax. We are glad to notice the work of an English firm in the application of individual motors to machine tools. The pamphlet issued by this Company illustrates in a striking manner what can be done in this direction. A speciality has been made of motor-driven lathes, planing machines, drilling and boring machines, shaping and screwing machines, multiple drills and plate-bending rolls. A number of excellent examples of these machines are given, the position of the motor being clearly shown.

Gas-Plants.—THE HORSEHAY COMPANY, LTD., Horsehay, Shropshire. A most elaborate production, telling in pictures of the works and products of this Company, has recently reached us. For electrical engineers the chief item of interest is that dealing with Wilson's patent producer gas-plant. A 500-h.p. installation, supplying a number of gas-engines driving shafting and dynamos at the works, is doing good service. These plants use bituminous slack, and an average consumption of $1\frac{1}{4}$ lbs. of coal per i.h.p. hour is guaranteed.

CENTRAL STATION PRACTICE.

Exhaust Heads.—HOLDEN AND BROOK, LTD., West Gorton, Manchester. List No. 71 is a single leaflet dealing with an exhaust head, which is made a speciality of by the Company. We need hardly remind central station men that this useful device will prevent the dripping of greasy water on to the station roof, will reduce the exhaust noise and cause less annoyance to neighbours.

Conveying Plant.—GRAHAM MORTON AND Co., LTD., Leeds. Catalogue No. 940 is a superb production and should be in the hands of every station engineer. He will find his smallest and greatest wants in the way of coal-handling plant, supplied in this publication. The 150 pages are a continuous testimony to the enterprise of the firm as well as to the printer's art in catalogue production.

Engines.—J. & H. McLAREN, Leeds. The story of the work of this well-known northern firm and its equally well-known products is well told in a superb production of some twenty pages. A glance over this publication implies that the reciprocating engine is not yet dead, but is in fact still a keen rival to the steam turbine. Messrs. McLaren's specialities are medium-speed engines of large power and of the triple-expansion type. A high-speed engine is also made of the same type, and many of these are doing good service. Engines up to 3,000 i.h.p. have been built.

Paints.—CROSIER, STEPHENS, & Co. Newcastle-on-Tyne, are agents for "Acheson Graphite," a product of the electric furnace, which, when suitably treated, makes an excellent coating for steel work and machinery of every description. The graphite, which is converted from anthracite coal in the electric furnace and used for paint, is 90 per cent. carbon. From exhaustive experiments this substance will remain unoxidised, and is consequently an invaluable ingredient for preservative paint. Engineers interested should apply for copies of the instructive booklets, issued by the parent company and supplied through their agents.

Boilers.—THE HARDIE-THOMPSON CO., 110 Cannon Street, E.C. It is evident from the first pamphlet of this Company that there are still modifications of the water-tube boiler which can be commercially exploited. The "Hardie-Thompson" boiler differs from the usual water-tube type in that no brick-work is required, and the tubes have no lower header, being merely screwed into the water-drum at one end, the other being blocked. Each tube is fitted with a diaphragm extending almost throughout its entire length, but less in diameter than the top and easily placed in position and withdrawn. The diaphragm is bent in a sinuous form, and is so arranged that the steam and water escape to the top side of the diaphragm, thus setting up immediate and rapid circulation.

LIGHTING AND HEATING.

Accessories.—THE GENERAL ELECTRIC CO., LTD., Queen Victoria Street, E.C. List X 1,060 gives particulars and prices of main switches, cut-outs and house-service fuses. The list is arranged to file with the regular publications of the Company, and is produced in their usual excellent style.

Forthcoming Events

Exhibitions.

Universal Exposition, St. Louis, U.S.A.
Now Open. Remains open till *December* 1, 1904.

Industrial Exhibition, Cape Town.
November 1904 *to January* 1905.

Tramway and Light Railway Exhibition.
July 3 *to* 14, 1905.

Meetings, &c.

The Institution of Mechanical Engineers. Session 1904-1905.

Ordinary Meetings as follows:

1904.	*November* 18.	Friday.
	December 16.	"
1905.	*January* 20.	"
	February 17.	"
	March 17.	"

The Institution of Electrical Engineers. Session 1904-1905.

1904.	November		21
	December	8	15
1905.	January	12	26
	February	9	23
	March	9	23
	April	13	27
	May	11	*25

* This will be the Annual General Meeting; the time and place will be notified to members hereafter.

Meetings of Local Sections.
Session 1904–1905.

	Birningham	Dublin.	Glasgow.	Leeds.	Manchester.	Newcastle-on-Tyne
1904, November	23	—	—	17	29	21
December	14	8	13	15	13	12
1905, January	18	12	10	19	17, 31	16
February	15	9	14	16	14, 28	6, 27
March	15	9	14	16	14, 28	20
April	12	13	12	13	11	—
May	10	11	10	—	—	—

NOTE.—The above dates are subject to alteration.

Manchester Section of the Institution of Electrical Engineers. Session 1904-1905.

November 29, 1904.—"Compensating Alternate-Current Generators." Miles Walker, A.I.E.E.

December 13, 1904.—"High-Tension Switchgear." L. Andrews, M.I.E.E.

January 17, 1905.—"Electric Driving in Textile Factories." H. W. Wilson, A.M.I.E.E.

January 31, 1905.—"Some Points on the Selection of Electric Cables." L. B. Atkinson, M.I.E.E.; C. J. Beaver, A.M.I.E.E.

February 14, 1905.—"Manchester Tramways Power Supply." S. L. Pearce, M.I.E.E.; H. C. Gunton, A.M.I.E.E.

February 28, 1905.—"Mechanical Construction of Steam-Turbines." W. J. A. London, A.I.E.E.

March 3, 1905.—Annual dinner.

March 14, 1905.—"Low-Tension Thermal Cutouts." Professor Schwartz, M.I.E.E.; W. H. N. James.

March 28, 1905.—"Use of Electrical Energy in Mines and Collieries." M. B. Mountain, M.I.E.E.

April 11, 1905.—General Meeting.

Students' Section.

(*See* Students' Section this issue for an important article on work of this section.)

The following arrangements have been made:

November 30, 1904.—"Motor-Controlling Switchgear." L. J. Pumphrey.

December 7, 1904.—"The Gordon Electric Light Installation at Paddington, 1884–1904." M. G. Tweedie.

January 18, 1905.—"Notes on the Construction and Maintenance of large Telephone Exchange Equipments." A. L. Stanton.

The Electrical Magazine.

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THEO. FEILDEN.

Associate Editors: Leading Authorities in every branch of Electrical Activity.

VOL. II. NO. 6. (12th Issue.) LONDON. DECEMBER 19, 1904.

ELECTRICITY IN AGRICULTURE.

ELECTRICAL engineers have always had elevated ambitions, but a good many of these have never got beyond the embryonic stage. There are some optimists in our midst who regard electricity in its wider sense as capable of ultimately forming the basis of all industrial operations. They would assign it a place in the future such as no other power-agent coming under human control could, as far as can be discerned, occupy. Judging by the manner in which electromotors are being applied to the operation of machinery in almost every trade it seems but natural that so important a power-agent should find its way into agricultural operations. The science of employing electricity beneath the soil to facilitate the germination of seeds and the application of light to plants and flowers already in a flourishing condition is receiving careful attention. The phenomenon, for such it appears to be, associated with this seemingly drastic application of electricity, is, however, being gradually unfolded and although it is evident we are, at present, on the fringe of important discoveries in this respect, too much must not be looked for in this quarter at present. On the contrary, the use of electro motors for driving farming machinery presents to the practical mind a problem much more easy of solution. In practice the difficulty lies not in the motor itself but in the method of supplying it with power. Agricultural implements compared with machine tools, for instance, are crude to a degree, so that in driving them by electricity, modifications such as have been found necessary with machine tools would not be needed. Fixed appliances like churns, cream-separators, chaff-cutters, mixers, and pumps can all be driven by individual motors or from line shafting as may be most convenient. The only implements which seem to demand special treatment are those used in the actual tilling of the land, and of these the plough is most important. In this case the motors require to be applied either for the operation of winding drums which pull the plough backwards and forwards, or in the actual movement of the plough itself. For the driving of threshing machinery and appliances for the treatment of grain, portable motors are apparently most suitable. For the electrical engineer then, the application of power to agricultural implements resolves itself into a problem of transmission and distribution. Two solutions to this present themselves. First, that afforded by the isolated plant furnishing current to a large estate or to a number of farms, and, secondly, that in which the power is supplied from a power station installed and operated by a company distributing energy in bulk over a wide area. As far as this country is concerned it might appear at sight that the first solution would be the most feasible and would

appeal more to British agricultural interests. The installation of a central power-plant to furnish energy over a definite farming area would, however, involve considerable initial outlay for plant and mains. In making such a suggestion to a group of farmers this expenditure of capital on what is really dead material would probably be too palpable. Much more encouraging is the suggestion that power be derived from the mains of an independent company furnishing energy in bulk from one or a number of stations. This is now rendered even more feasible by the new Board of Trade regulations, which permit the employment of overhead wires. In country districts the poles and lines would not disfigure the scenery and their use would make the system far more flexible. On the score of reliability they may not seem equal to underground cables, but the periods in which breakdowns are likely to occur are winter months when storms are more frequent, and the farmer has less important work in hand. This seeming defect cannot, however, be logically urged as transmission lines in important industrial centres in America and on the Continent are successfully operated under climatic conditions scarcely ever experienced in these islands. The power companies at present operating in Great Britain have laid down stations in close proximity to large industrial districts, and as far as we can gather have made little or no provision for supplying farmers with cheap power. It is true that the great majority of the companies have only manufacturing areas to supply and the revenue to be derived from the sale of current in agricultural districts adjoining these would be comparatively small. There are, however, at least two companies having powers of supply in Kent and Gloucestershire respectively, who might, with advantage, consider the feasibility of furnishing cheap power to the farmers and hop-growers in the vicinity of their power stations or on the line of route of their transmission cables. Judging by work which has been done in this direction on the Continent by hydro-electric plants, a brief review of which is given in our Special Articles Section this month, there is business to be done in supplying farmers with electric power. It is conceivable that a community of farming interests bordering some of these transmission lines has made application to the supplying authorities for electrical energy, but we are inclined to think that such plants as have been put into operation are the direct result of enterprising manufacturers who have summed up the situation and supplied what has evidently proved to be a long-felt want, and, moreover, one which has proved remunerative. It is in some such spirit as this that we hope electrical engineers in this country will grasp the possibilities of the situation, and meet it with proposals in every way comparable with other results achieved by them in the application of electric power to various industries. The tilling of the land is apt to be regarded as a matter of secondary importance and something which can drag its weary burden along in the rear of industrial progress with scarcely a word of encouragement. This is not as it should be, and taking an example from the promising experiences of our Continental friends, we should be able to apply a stimulus to agriculture in this country which might rival protection itself in raising the value of the land and its products. Parliamentary powers have been granted to power companies, which, when brought into practice, will change the entire aspect of all industrial operations, and it seems only right that agriculture, which, at one time, was our staple support, and even now contributes largely of its best in the way of men and women to the community, should have some share in the undoubted benefits which electrical power can bestow.

__Electrical Manufacturers__ should not neglect to read the advice contained in the last paragraph of our "Final Word" on the opposite page

The World's ELECTRIC PROGRESS

Editorial · Commentary of · the · Month.

A FINAL WORD.

As this is the last opportunity we shall have of reminding our readers of the publication of the special Anniversary and Souvenir number in January, we avail ourselves of it and make no apology for so doing. In the rush of business our announcement last month may have escaped the notice of many of our numerous friends, and it is chiefly on this account that we give special prominence to the matter. Since publishing the November issue, our already valuable stock of data in preparation for the special number has been materially added to. American electrical engineers have responded heartily to our invitation for contributions and we anticipate placing before our readers matter of indisputable value and permanent worth. Numerous eminent electrical engineers in the United States with whom Mr. Feilden established friendly relations on the recent tour are co-operating with him, and, at the time of writing, have either sent in their contributions or promise them to arrive in time for publication. In every case the feeling has been unanimously expressed that such a record as we purpose publishing is an undoubted necessity, and there has been no lack of support from those whose association with the recent events contributes so much towards the success of the number. We must not, of course, make premature acknowledgments to any engineers who are with us in the production of this issue, but we feel compelled to impress upon our readers that the matter published in these pages will be of no ordinary character. We have already stated that the number will be a complete record of the recent American tour, the Congress and the St. Louis Exposition, and we must strongly emphasise this again. The events with which it will deal are regarded as the most significant to electrical men which have transpired during the past year. Though having no direct influence on the commercial aspect of electrical engineering, in their essence they contain the elements of a lasting good to that industry and strike notes which will subsequently find an echo in every corner of it. We reiterate these facts so that there can be no misconception of the permanent merit of the issue we contemplate publishing. We have carefully considered the question of associating the usual sectional matter of the magazine with that forming directly the basis of the special number, and after due deliberation have decided to exclude it. Our main object in taking this course is to give the number an individuality which it might not otherwise possess if material of an extraneous nature were published with it. Our regular readers will lose nothing by this arrangement, as the February number will be a complete survey of every branch of electrical work during 1904.

Before closing our last reference to the January issue we would like specially to commend its value as a medium for advertising. With the hall-mark of electrical authority upon it, with its high literary tone, with printing and illustrations of unusual quality, and with so stable a claim upon the attention of electrical men the world over, the issue we venture to think should receive exceptional consideration at the hands of manufacturers. The body of support accorded us by electrical authorities throughout the world in making the literary contents of this number an unprecedented success, will be effectually doubled if manufacturers will spontaneously come into line.

Electricians All! At various periods of the year our lay contemporaries are inspired to tell their readers something about electrical engineering. The subjects treated range from the design of an alternator to the harnessing of lightning, while occasionally advice is proffered on how to become an electrical engineer. The latest contribution to the series is *T. P.'s Weekly*, which acts in an advisory capacity on the last-named topic. Its message is delivered to all and sundry, probably to avoid offending any particular grade of its readers, and though in no way exaggerated in its essence, the flavoured terms in which it is couched, combine to make it a very spicy collation. The artisan is informed that "he may require for his day's work only a stucco of theory on a backing of native intelligence," while the engineer "must have the walls of his mental habitation constructed of accurate science well and truly builded together." Will members of these extremes in electrical engineering please note!

Sidelights on the New York Subway. The subway, despite the artistic arrangements of its stations and approaches and the taste displayed in their design has already been invaded by the bill poster. These tradesmen whose versatile pictures and announcements are the delight of a mercenary age, have been duly commissioned to beguile the moments of persons waiting upon the subway by indirectly appealing to their pockets. Unlike his prehistoric relations, who with ladder and paste-tin decorated walls and hoardings to the discomfort of passers-by, the subway poster leans his elaborate encomiums against the station walls. Those in authority who are responsible for conduct which to New Yorkers is little short of sacrilegious, have called down upon their heads the wrath of several hygienists. These gentlemen draw lurid comparisons between the zeal which prompted the Rapid Transit Commissioners to avoid corners in the station structure, in which dust and microbes could lodge, and the gilt-edged tin frames now resting on the platforms and harbouring behind their utilitarian forms the very germs which it was so anxious to exclude. This appeal for Art against mere usefulness comes strangely from the land of the almighty dollar.

Heresy at Brighton. A correspondent of a well-known Southern daily paper, writing at Brighton under the heading of "Domestic Electricity Supply," cannot be conscious of the heretical tone of his utterances on the subject of maximum demand. He has "flown into print" after wrestling with his electric lighting account and a courteous official at the supply-station, whose explanations would not "soak in." He pleads for a uniform rate of charge throughout the town, when he can check his meter as he would with gas. From our records we gather that both flat and maximum demand rates are in vogue, but presumably our perplexed friend is beyond the pale of the former. But does he not know he is in the very home of "maximum demanding," and that rank heresy bulges from every joint of his complaining carcase!

Arc Lamps in America. The position of arc lighting in the United States is lucidly summed up by Mr. Alton D. Adams in Special Articles this month. The growth of lamps chronicled therein is little short of stupendous, while, in no lesser prominence, stand the marked improvements made in means of furnishing current to these lamps. Referring to the latter first, we may recall the early plants supplying single lamps from individual machines, a method subsequently developed into the lighting of large numbers of lamps from a unit of considerable capacity. The employment of many arc lighters gave rise to belts and shafting, for driving from one to two engines, and, according to Mr. Adams, stations of this character are still plentiful in the United States. It is, however, specially interesting to note that steam driving is giving way to motor-coupled sets, both in alternating-current and direct-current plants, though even more interesting is the employment of constant current transformers for the series

operation of lamps. Modifications on these lines have greatly raised the standard of arc lighting in the States, and resulted in marked operating economies as can be readily imagined. What impressed us most, however, is the acceptance of arc lamps as the best form of illuminant for street-lighting purposes. This is the only possible construction to be put upon the very wide employment of these lamps. Americans have plumped for electric lighting, both public and private, consequently the gas interest has received little encouragement and kept to its own domain. Meeting electricity in the early days and, judging by events, presenting so doleful a contrast, gas has joined the lean kine, at any rate, for street lighting where electricity meets with so much approval. In a new country with a clear field before them, and the cream of modern science for the skimming, Americans would not hesitate to take such an opportunity, so that their whole-hearted employment of arc lighting need occasion no surprise. The same thing would happen, in fact is happening, wherever civilised man is expanding into previously uncultivated lands.

The Gas Exhibition.

OUR first impression on passing the turnstile admitting to the International Gas Exhibition at Earl's Court, was that under the goad of electric lighting the gas industries had not done so badly. With the glare of hundreds of high-pressure incandescent lamps in our eyes and their hiss in our ears, we were disposed to feel that they still had plenty of hard work before them. Again the feeling would come despite the effort to suppress it that gas lighting is the illuminant of the *bourgeoise*. It seemed difficult to couple the green glare of incandescent burners with the elaborate appointments of a modern mansion, hotel, restaurant, or ballroom. Throughout the tour of the Exhibition no rest is given to the eyes from the glare of thousands of lamps whose rays conveyed the feeling that they were the *multum in parvo* of artificial illumination. All attempts at associating Art with these luminous excrescences seemed to us dismal failures. Even though the inverted burner is the nearest possible crib to an electric lamp which the gas engineer has laid his hand on, neither in its arrangement on elaborate fittings either hanging from the ceiling or fixed in bracket form to the wall can it approach the original pattern. The problem of combining Art with gas lighting might be considered similar to that of embellishing the illuminating powers of a farthing dip with a modern

Electricity. Hullo, Gas! I thought you were dead.
Gas. Not a bit of it. Never better in my life.
The Daily Mirror.

pearl shade. The gas engineer, however, must undoubtedly be reckoned with in the future of electric lighting. Public opinion is very largely in his favour and public opinion is difficult to deflect. A glance at the attached illustration taken from a daily contemporary sums up very well the present attitude of the public towards gas lighting. Until the average layman can be persuaded to look further than the end of his own nose, so long will he place confidence in gas lighting. We say this with every deference towards a great industry. The point we wish to press home, however, is that despite the improvements which have been effected in burning gas at the end of a pipe and thus enhancing its illuminating qualities, gas lighting is very far from the ideal, and, moreover, must give place to

some form of electric illuminant. When all has been said and done in the way of economically extracting from gas whatever illuminating qualities it has, further improvement would be impossible, and the original inherent drawbacks would still be present. Electric lighting, which has pursued the even tenor of its way since its establishment, has only just awakened to the fact that gas is a very powerful competitor and that the original glow-lamp is not the most suitable weapon to meet it. With the introduction of the Nernst lamp a decided step forward has been made, and this seems to augur well for the future. It is not, however, the electrician's last word. He has really only just bestirred himself, but unlike his gas rival he has practically unlimited resources at his disposal. The *ultima thule* of artificial illumination—light without heat—lies at the end of the path of research upon which he has set his foot, and the sooner he is given substantial encouragement in the attainment of this end so much the better for civilisation. Our gas friends must, however, be complimented upon the energy which they have displayed in organising the recent Exhibition, and on the splendid examples of what they are able to accomplish with gas lighting on scientific principles, but we would like to remind them of the fact cited above. Further, we would commend to their notice the excellent opportunities which the future holds out for the utilisation of the gas they are now serving up so scientifically to the public, for operating gas-engines directly connected to dynamo electric machines.

I.E.E. Local Sections.

THE presidential squibs have now been let off at all the local sections, with varying detonating effect, and the reading of papers has begun in real earnest. Of the Presidential Addresses little can be said. At Birmingham, Dr. W. E. Sumpner in dealing with the use of iron in alternate-current instruments, paid a great tribute to Lord Kelvin whose work, when Sir William Thomson, in placing at disposal reliable direct-current instruments at a time when measuring apparatus was crudely imperfect could not be too widely appreciated by electrical engineers. Mr. C. D. Taite, at Manchester, was fired with the enthusiasm of his recent American trip, and, among other matters, he considered worthy of greater attention in this country was the treatment of central-station employees. "On the other side," the station staff from the humble stoker to the chief assistant have facilities for acquiring current knowledge in libraries and club-rooms considerately provided for them in most of the large stations. The recognised hobnobbing of these extremes with, of course, the intermediates is conducive to exchange of ideas, and also to self-improvement, especially among the lower grades of the staff. Doubtless, many central-station men would appreciate this boon as opportunities for intercourse on the station are few. The plan, if put into practice, would also do much to remove many petty jealousies which inevitably arise in works of this character. Mr. Walter Emmott was very sanguine at Leeds of the future of electric light and power, and looked for remunerative expansion despite the seeming depressed condition of trade. His future hopes are placed in the gas-engine with some improved form of generator, while he further expressed a sentiment which we have held for some time—that the gas engineer, now actively competing with electric light and power, would be selling power gas to the electrical engineer at no distant date. At Glasgow, Mr. R. Robertson was emphatic in his references to the application of electric power for mining, and, speaking of the departmental Committee, expressed the opinion that this work should not be hindered by codes of rules or legislative enactments, though carefully devised legislation, affording a latitude compatible with safety, would do much to encourage the use of electricity in mines among prejudiced alarmists.

In the matter of papers, the Institution and Sections have begun well. The first paper before the former body on the stream-line method of observing changes analogous to those in magnetic fields, especially in toothed core armatures, by Messrs. Hele-Shaw, Hay, and Powell, received quite an ovation, doubtless because the usually rigid atmosphere of the lecture room was relieved by optical

demonstrations of the method with which such successful experiments had been made. Leeds Section followed up the president's remarks on gas-engines by a paper on the subject from Mr. Hugh Campbell, but to this we make reference in Central Station Practice this month. Mr. Miles Walker at Manchester dealt exhaustively with compensated alternators, and in an excellent paper described the methods suggested or employed for compounding purposes. These seem to be a mass of extra commutators and brushes and generally conveyed the idea of complication. The author's suggested method, which has been successfully experimented with by the British Westinghouse Company, is simplicity itself in contrast, and for its particular purpose should be widely adopted. It comprises the use of a constant field and of armature reaction to strengthen the field on load, the field poles being in two parts. One of these is a saturated pole surrounded by the field coil proper and an unsaturated pole trailing behind the other, the whole being surrounded by another coil. This pole becomes highly saturated by armature reaction, and increases the armature electromotive force. The wave form has been found to approach closely the sine wave but the machine is not suitable where the power factor decreases with increase of load, a condition, however, not often met with in modern practice.

We shall look for a maintenance of this good beginning throughout the coming session.

Mr. Sheardown recently presented to the Dublin Section a concise account of electricity supply in and around New York, for both lighting power and traction. His paper will form a valuable referendum on the subject for some time, and we would recommend it to the notice of our London readers as recording a state of things which might well be copied by London supply authorities. We refer to the uni-control of the light and power interests in New York. The work of the New York Edison Company, as the largest member of the Association of Edison Illuminating interests, in affording New Yorkers a modern and reliable supply of electricity is worthy all praise. It is interesting to hear that the consumer's voltage has not been raised above 120 volts, and that no scheme for raising the pressure has ever been entertained.

A Correspondence Class in the Telegraph Section.

A NEW feature in journalism, which we hope will prove acceptable and beneficial to a very large number of readers, will be commenced in our number of February next. The scheme takes the nature of a correspondence class for all those engaged in the telegraphic and telephonic professions. No fees will be charged, and all may profit by it, at a cost within the means of the humblest individuals in either of the services, and at a considerable saving compared with that entailed by other methods of teaching by correspondence.

The only expenditure that will be incurred by those who desire to participate in this tutorial work will be the price of the magazine, which, independent altogether of the new feature, supplies unequalled value in the latest and best information in every branch of electrical science and industry, at the modest sum of sixpence per month. Each month we shall publish a list of six comprehensive questions to which all our constituents in this Section are invited to send in their answers over a *nom de plume*. These answers will be carefully examined, and corrected by the conductor of this special subject. The corrections will be pointed out under each *nom de plume* in the following issue of the magazine, and specimens of the most accurate and lucid answers will be published together with a fresh set of six questions.

The problems set will be arranged to suit the requirements of those studying in technical telegraphy and telephony, for the City and Guilds of London Institute's examination, as well as for those who may be called upon to pass departmental examinations in either branch of these sciences. This new departure has been fundamentally designed to fill a particular want in outlying districts where there are no technical schools, or special facilities for study in these specialised subjects, as well as for the vast number of officers engaged in telegraphy and telephony in the Post Office, in the Telephone Companies, and in the Railway and Foreign Telegraph Companies, many

of whom have not an opportunity of attending night classes regularly, but who may have facilities for home study without the pecuniary means necessary for thoroughly carrying it out. To all those classes we specially appeal, and invite them to begin at once attempting to answer the questions set, and to send in their answers promptly and regularly, not later than the 5th of every month. All answers should be written on one side of the paper only, and a separate sheet should be used for every question. Correspondence should be addressed to the offices of the magazine, and it must be clearly understood that the corrected papers will not be returned by post. The scheme is capable of considerable development depending upon the amount of support it receives, but, in the meantime, is tentative and subject to withdrawal. It is purely an attempt to help those in search of enlightenment, and is neither an appeal to the curious at the expense of the industrious, nor a desire to attract from the legitimate and wholesome work of the technical schools. It is *inter alia*, intended to maintain a healthy interest in technical subjects amongst those who have once been students, but who are not stimulated to be students always for lack of some such encouragement as we now offer. In the February issue a full introduction to the subject will appear along with the first set of questions.

Electric Traction for Railways.

LAST month's issue and the present number contain further instalments of Mr. W. M. Mordey's articles dealing with the various aspects of main-line electrification, this series having been extended to include additional data directly bearing on the subject. Previous to the November issue Mr. Mordey had given particulars and data of alternate-current systems, and our readers need no reminder of his strong advocacy of one-phase methods. His indictment of the direct-current system even for short lines will, we are sure, command special attention, and it should tend to dispel what proves, in the light of his arguments, to be a misguided opinion as to the efficiency of this method. The details published last month of the working results on the Liverpool Overhead Railway, the somewhat similar details given in this issue of the Central London Railway, and the comparisons drawn between the two, contribute strongly towards a support of Mr. Mordey's contention that the efficiency of direct-current driving, especially with series-parallel control, is far below what it should be. At Liverpool where the runs are short and made over level track the unit input is chiefly expended in acceleration, as Mr. Mordey shows, and retardation, in the absence of any method of returning power to the line, is only accomplished by applying the brakes. The figure, given in our first issue (January 1904), of 50 per cent. as the loss due to braking, was substantially supported by Mr. Mordey in our November number, and the fallacious reasonings by which the overall locomotive efficiency could be shown as 71 per cent. were clearly exposed by him.

His treatment of the Central London Railway is none the less convincing, and the energy account given indicates that in spite of conditions, decidedly favourable in comparison with the Liverpool line, the working results are disappointing. Acceleration and retardation on the Central London are assisted by a special construction which places all stations at the top of little hills. Presumably the designers of the line adopted this expedient partly because the direct-current system with series-parallel control was far from the ideal in the matter of working results. The switchback profile of the tube is one of its noteworthy features which reflects creditably on the foresight of the designers but figures relative to the additional cost of this construction over a comparatively level tube would probably afford the best guide to the opinions of the engineers responsible, regarding the efficiency of direct current driving as they found and applied it to the Central London Railway.

ARC LIGHTING IN THE UNITED STATES.

(*Specially Contributed*) *By* ALTON D. ADAMS.

ARC lighting began a quarter of a century ago with open arcs connected one per circuit, and is now largely carried on with enclosed arcs connected often with one hundred per circuit. In the beginning all arcs on this side of the Atlantic were operated from direct-current dynamos, now a large percentage of the arcs are supplied by constant-current transformers. In the meantime many changes have been made in the development of current for arc lighting, and in the volts and amperes at each lamp.

Boston, Massachusetts, was the scene of one of the earliest arc-lighting plants in the United States, and plants in that city and its suburbs illustrate to-day substantially every change that has taken place in the art. Charles Francis Brush, in October 1878, exhibited an arc dynamo and lamps at the Mechanics' Fair in Boston, and this lighting plant went into regular use in a clothing house at the corner of Howard and Washington Streets, on November 9 of the same year. The construction of this dynamo and lamps is an interesting illustration of the state of the art at that time. In outline the dynamo resembled the later machines designed by Mr. Brush, had four cast-iron magnet cores with flat pole-pieces presented to the ends of a cast-iron armature core, and was wound with four separate circuits connected to as many pairs of independent commutator segments. The armature core had eight wide radial slots on each end, and the eight coils were wound into these slots and then connected in four separate pairs to form the four circuits. Each circuit was connected with a single arc lamp, and as the lamps had no automatic cut-outs a circuit was completed only through the shunt coil of the lamp magnet when the carbons burned out. Four circuits of bare No. 6 copper wire were run to the parts of the clothing store where the arc lamps were located, and each wire was secured by iron staples driven over it into the woodwork. Uncoated, square carbon rods were used in these lamps, and their cost was twenty-five cents. (12½ pence) each. Such was arc lighting at Boston in 1878, in the first plant ever installed there for regular service.

Less than a decade saw a great change in the art, for on August 9, 1887, when the National Electric Light Association met in Boston for its annual convention, the Ferdinand Street electric station, one of several that were then operating in the city, contained sixteen Brush constant-current dynamos of sixty-five lamp capacity each, seven for thirty lamps each, and two Thomson-Houston dynamos designed for thirty and fifty lamps respectively. The lamps of each of these dynamos were all connected in series, as long before the date just named the automatic cut-out had been perfected. At that time most series

arcs operated with about 6.6 or 9.6 to ten amperes, and with forty-five to fifty volts per lamp, as the "short" arcs taking about twenty-two amperes at twenty-five volts had mostly gone out of use. Most of the arc lamps then in use, both inside and out, were of the series type connected to constant-current dynamos, but since then multiple arcs operated from constant-pressure mains, at about 110 volts, have, in the great majority of cases, displaced series arcs for interior commercial service. As a rule the advantages of series distribution for arc street lamps have caused its retention in that service despite all the changes that have taken place in voltage and current at the arc, and in the generating equipments employed.

As late as 1890, the number of single open arc lamps in use exceeded the number of double arcs in Massachusetts, and probably in the entire country. The double lamps were rapidly gaining, however, because of the large saving of labour which they made possible in street lighting, by doubling the number of hours that a lamp would burn with one trimming. Ten years after the date just named, the number of double arc lamps in use had increased to nearly three times the number of single open arcs in Massachusetts, and this result was no doubt representative of that in other states. With the general introduction of enclosed arc lamps, about 1898, the numbers of both single and double open arcs began to decline, and, at the present time, the enclosed type far outnumbers both the others. At first the enclosed arcs found favour especially for commercial service, but they have gradually come to do a large share of the street lighting. One reason for the rapid increase in the number of enclosed arcs has been the desire to do arc lighting, both interior and exterior, with alternating current, which is not practicable with open arcs. Another reason is the greater desirability and safety of enclosed arcs for interior illumination, and also their saving over open arcs in the consumption of carbons and the labour of trimming. The superiority of enclosed arcs in these particulars has also worked a change in the relative numbers of street and commercial lamps.

Referring again to the reliable figures of the industry in Massachusetts, as an index to the situation in all the states, it appears that, in 1897, commercial lamps formed only 40 per cent. of the entire number of arcs in use, while, in 1903, street arcs represented 53 per cent. of the total number, and the remainder were commercial lamps.

With enclosed arcs came changes in both the volts and amperes per lamp. The increased length and changed character of the enclosed arc necessarily raised the voltage per lamp from forty-five or fifty to seventy-five or eighty, and a corresponding decrease of current followed in order to keep the watt consumption of each lamp at about what it was with the open arc. Decrease of amperes per lamp, for commercial service, has also been carried far enough to materially reduce the watts per arc in many cases below what was common with open lamps. As a result of these changes, instead of the six to ten amperes of current common in open arcs, some enclosed arcs are now operated with as little as three amperes. The increased voltage of enclosed arcs has rendered them more suitable than open lamps for commercial service, because it was necessary to connect the open type in pairs to 110-volt circuits in order to obtain fair economy. As each enclosed lamp requires about eighty volts, its connection singly to 110-volt mains gives an efficiency nearly equal to that of two open arcs in series, and permits much greater freedom of location.

With enclosed arcs came the necessity to increase either the number or the voltage of circuits for lamps in series, and the latter alternative has been more generally chosen. As a result many circuits for arc street lighting are now operated at 8,000 to 10,000 volts, and supply from 100 to 125 enclosed arcs each, connected in series. This rise in the voltage of series arc circuits has occurred in direct as well as alternating current distribution, and has carried with it the voltage of constant-current arc dynamos as well as that of transformers. While an envelope for the arc was necessary to make its operation by alternating current practicable in general service, the advantages of the enclosed arc are such that it has been adopted for the majority of even direct-current street

lamps. As a rule the substitution of enclosed for open arcs has most materially changed the number of watts per street lamp. Thus, in Boston, where more than 3.500 enclosed arc street lamps are now in use on direct-current circuits, each lamp operates with about 6.6 amperes and seventy-six volts, or 500 watts, instead of 9.6 amperes and forty-five to fifty volts, as in the days of open arcs.

Changes in the distribution of arc lamps are small compared with the changes in the generating equipments for series street lamps at electric stations. In the old days of open arcs each series circuit usually had an independent dynamo belted either to a steam-engine or a main shaft at the station. Belt connections were the rule because the arc machine usually operated at speeds of 700 to 1,200 revolutions per minute, and no engines could be had for direct connection. The old Ferdinand Street Station above mentioned, a model in its day, was a good illustration of one common plan of driving arc dynamos, by locating the engines and shafting on a lower floor and the dynamos on the one above, with belts running through the upper floor to connect engine and dynamo pulleys. Such independently driven dynamos seldom had an individual capacity of more than sixty-five arcs of 2,000 candle power nominal capacity, like the old Brush No. 8, the equivalent of about 32.5 kilowatts. During the past decade the capacity of single arc dynamos has been pushed at least as high as 8,000 volts and 6.6 amperes, or 52.8 kilowatts, and the speed of machines of this capacity has been brought as low as 500 revolutions per minute. In a comparatively few stations arc dynamos of about this capacity and speed have been direct connected in pairs to high-speed engines, and at each end of an engine shaft. The great majority of stations, however, that still cling to mechanical driving between the engines and arc dynamos, and their name is legion, continue to make the connections with belts.

Despite the tenacity of the small, high-speed arc dynamo for the mechanical drive, many of the best stations have relegated such machines to the status of secondary apparatus by coupling them either singly, or in pairs, direct to electric motors. This step solves at once the problem of concentrating the load of arc lamps with any other on several large engines and generators of uniform type. As far as this practice has gone it is mainly confined to stations where the main generators develop alternating current, and to sub-stations where such current is received. Examples of this method of driving arc dynamos may be seen at the L Street generating station in Boston, where there are twenty-one of the motor and arc dynamo sets, and at the sub-station where energy developed at Niagara Falls is distributed for public lighting in Buffalo, New York. At the Boston Station each of the twenty-one sets for arc street lighting consists of a 150 kilowatt, 2,200 volt, 60 cycle, three-phase, synchronous motor direct coupled to a pair of 8,000-volt, 6.6 ampere, single-circuit dynamos, one at each end of the shaft. Each of the arc sets at the Buffalo sub-station includes a 150-kilowatt 352-volt, 25-cycle, three-phase synchronous motor driving, in some cases, two, and, in other cases, three 8,000 volt, 6.6 ampere, single circuit dynamos direct connected. There are thirteen of these last-named sets, and they include thirty-two arc dynamos. At both the Boston and Buffalo plants, the arc machines are of the Brush type with slotted Gramme ring armatures, and four poles each. In both the Boston and Buffalo plants each of the 8,000 volt, 6.6 ampere dynamos is rated for 100 arc lamps that give 2,000 nominal candle-power and consume about 500 watts each. Street lighting in these cities before the adoption of enclosed arcs was done with 9.6 ampere lamps, each of which operated with forty-five to fifty volts, so that the rejection of open arcs involved an increase of 5 to 10 per cent. in the consumption of energy per lamp. At the Buffalo sub-station each motor set for arc lighting formerly consisted of one of the 150 kilowatt motors already mentioned, direct coupled to a pair of 9.6 ampere, 125 lamp dynamos for open arc work, but with the change to enclosed arcs the ampere capacity of the dynamos was reduced to 6.6 and the voltage of each was raised to 8,000 by different winding. Though this plan of motor-driven arc dynamos has been adopted mainly in stations where alternating current is

generated or received, it is obviously equally applicable in plants where the main generators develop only direct current. In fact, the wonder now is that stations developing direct current at about 250 or 500 volts, and also carrying a load of series arc lamps, did not long ago adopt the motor method of driving arc dynamos, which contributes materially to steam-engine economy. While arc machines thus driven present one solution of the problem of uniformity in the main generating equipments of electric stations, another and even more popular method with station managers is found in the substitution of alternating for direct-current arcs, and of constant-current transformers for arc dynamos. Many engineers maintain that the direct-current lamps give better results in street lighting than can be obtained with the alternating arc, but, on the other hand, the alternating system is cheaper to instal and operate, if the available current has a frequency suitable for arc service. With alternating current of constant pressure at suitable frequency the choice of apparatus in its transformation for arc service lies between constant-current transformers or regulators on the one hand and motor-driven dynamos on the other. For such cases the constant-current transformers represent a saving of 75 or more per cent. in the investment, and 10 to 15 per cent. in efficiency of operation, over motor-dynamo sets.

If equal illumination is to be obtained with each type of equipment, however, it seems that the gain in constant current transformers over motor-dynamos is fully offset by the lower efficiency of alternating arcs. Where the alternating current must be changed in frequency before it can be applied in arc lighting, the motor-driven, constant-current dynamo set costs less and has about the same efficiency as the alternating-motor generator with transformers for constant current. An interesting illustration of transformation and conversion of alternating current for series arc lamps may be noted at the new sub-station in Schenectady, New York, where energy developed at Spier Falls, thirty miles away, is distributed for the entire electric lighting and railway service of the city. The energy from Spier Falls reaches the works of the General Electric Company, a few rods distant from the Schenectady sub-station, in the form of three-phase, forty cycle current at about 26,000 volts. In these works transformers lower the voltage to about 10,000, and the current for the city service then passes by underground cables to the sub-station just named, where a part of it enters 10,000 volt, three-phase, forty cycle, synchronous motors. Each of these motors is direct connected to a 2,300 volt, three-phase, sixty-cycle generator, and from these generators the current goes in part to a group of eight constant-current transformers of 4,000 volts and 6.6 amperes individual rating. To each of these transformers a single circuit of series enclosed arc lamps is connected. One striking feature of an installation of this sort is the fact that, assuming an efficiency of 100 per cent. for all the electric equipment, the capacity of this equipment at the receiving end of a transmission line amounts to four kilowatts for every kilowatt of work delivered to the series arc circuits at full load. With motor-driven arc dynamos and step-down transformers for the motor, the corresponding capacity of apparatus at the receiving end of a transmission line would be three kilowatts. It is thus evident that the necessity for a change of frequency in alternating current for arc lighting adds two units of capacity in equipment for each kilowatt delivered at full load, if alternating arc lamps are employed. For such lamps the general practice in the United States is to employ current of sixty cycles per second. At Schenectady the forty-cycle current was tried with arc lamps, but its use for that purpose was abandoned as unsatisfactory. In the cities of Albany and Troy, New York, where energy for electrical supply is also drawn from Spier Falls, a variation from the methods already noted of driving arc dynamos is in use. At the stations in these cities the arc dynamos, that were formerly driven by steam-engines through the medium of main shafts and belts, remain connected to the main shafts as before, but these shafts are in turn driven by synchronous, belted motors instead of steam-engines. This arrangement saves a little in the capacity of motors if all the arc dynamos are never

in use at one time, is cheaper in cost than direct-connected sets, and is now a rather common practice.

In Massachusetts, at the middle of 1888, a decade after the birth of the central-station industry, these plants had a total of 6,579 arc lamps, and, in 1903, fifteen years later, the number had risen to 27,524. Unfortunately, Massachusetts seems to be the only state that has kept a record of its central-station industry. Strange to tell, the Federal Government never compiled statistics of central electric stations in all the states until 1902. The Federal Census of 1890 contained a record of central stations in the State of New York, the District of Columbia and the city of St. Louis, and no more. In the year last named the central stations of New York state had 19,834 arc lamps, and, in 1902, the corresponding number was 59,130. For the entire United States, in 1902, the total number of arc lamps connected with central stations stood at 419,561. Of these the municipal stations operated 50,795, the street railway stations 33,863, and the private central lighting stations 334,903 arc lamps. Of the commercial arcs 42,988 were open, and 130,985 were enclosed. For street lighting there were 138,684 open, and 73,041 enclosed arcs.

Alton D. Adams.

SINGLE-PHASE COMMUTATOR MOTORS. III.

By Prof. Dr. F. NIETHAMMER.

(Concluded from page 456.)

In my previous articles I have already mentioned that Brown and Boveri, Switzerland, are perfecting a single-phase system using the repulsion motor and doing all regulation by brush-shifting. This scheme proposed by Max Deri is described in the Swiss patent 28,964, the motor has two systems of brushes, for a bi-polar motor four brush-sets, Fig. 1. One system (*a a*) has its axis coinciding with that of the stator-field *f*, the other system *b b*, is shifted by an angle α which is nearly nought at standstill, and is increased corresponding to torque and speed. Both systems may be shifted, one alternately remaining in the field axis, starting, reversing, and braking being done effectually in this simple way. One brush set of one system is directly connected with one set of the other system.

The Lahmeyer Company, Frankfort, which is also manufacturing the Schuler motor, is also developing a compensated repulsion motor for railway purposes (Fig. 2). On the commutator supposed to be bi-polar there are four brush sets eighty degrees apart from each other. The first and second brush set is interconnected by a short circuit and the third and fourth as well. The connecting points are closed on the secondary winding of a regulating transformer T, whose primary is fed by the line in multiple with the field, the secondary having a series of taps. The working conditions are similar to those of the compensated motor, Fig. 6 (issue of October, p. 346). This Lahmeyer

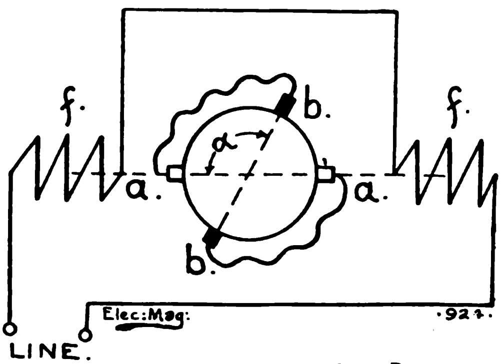


FIG. 1.—BROWN-BOVERI REPULSION MOTOR DIAGRAM.

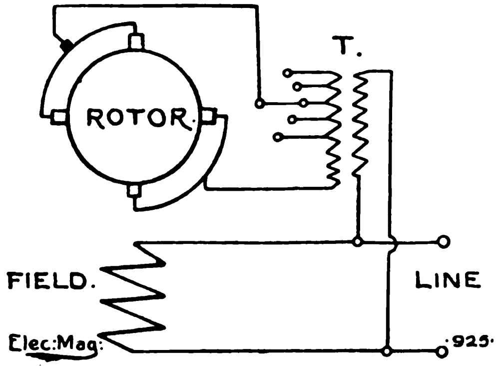


FIG. 2.—SCHULER RAILWAY MOTOR DIAGRAM.

motor is a shunt motor which type is also developed with only one brush system on the commutator. In Fig. 2 the motor is reversed by a double-throw switch in the secondary winding of T. In a great many cases alternate-current railway lines have to be extensions of existing direct-current net-works, giving rise to these two important conditions :

(1) The alternate-current motors must be fed from the high-tension three-phase transmission line with twenty-five cycles. As to this point there is no difficulty neither for three-phase nor for single-phase car equipments; in the last case it is advisable to transform the three-phase into two-phase currents by conveniently connecting up the line transformers and to feed the trolley-line sections both ways by the two phases.

(2) The more difficult condition is to equip line and cars in such a way that all vehicles may be equally well fed by high-tension alternate current and by direct current. The fulfilment of this condition is the most characteristic feature of the recently opened Schenectady extension line of the General Electric Co., which I need not describe in detail here. It is interesting that this Company with the widest and most thorough experience in electric traction has given up the repulsion motor to use the series motor (Fig. 3) with a distributed compensating winding shifted by half a pole-pitch against the main-field winding *f*, and in series with the main current. This auxiliary winding resembles the well-known Ryan winding of direct-current machines neutralising, as far as I see, the armature cross-ampere turns, as well as the reactance voltage of the short-circuited coils. The stator has no projecting poles, but a two-phase winding equally distributed in slots. Both the 600 volts direct current and the 2,200 volts alternate current are collected by trolley wheels, the high tension by a lateral trolley, both trolley wires being on the same poles. The 50-h.p. motor for 200 volts across terminals seems to have an air-gap of 2 mm. or more. The step-down transformer which is not used for regulation, is cooled by air draught. The total motor efficiency as single-phase motor is lower by 5 per cent. against the direct-current working. The power factor is 90 to 95 per cent. The kilovolt amperes input for a complete run on the suburban line are nearly 50 per cent. higher for alternate current than for direct current. Starting and regulating is effected for both currents by the same series-parallel control using the same five resistances, and the same controller, the efficiency of acceleration being somewhat lower than for voltage control. For direct current the four field coils are in series, for single-phase work two coils are in multiple.

Ganz and Company are just building a three-phase line in Canada where, as I am informed, the same condition has to be fulfilled, viz., the same cars have to run on three-phase and on direct-current lines. Probably the motors are equipped with three slip-rings and a direct-current commutator on the same rotor shaft, both being connected to the same armature winding; the three-phase voltage is reduced to the corresponding value by transformers, and fed to the slip-rings,

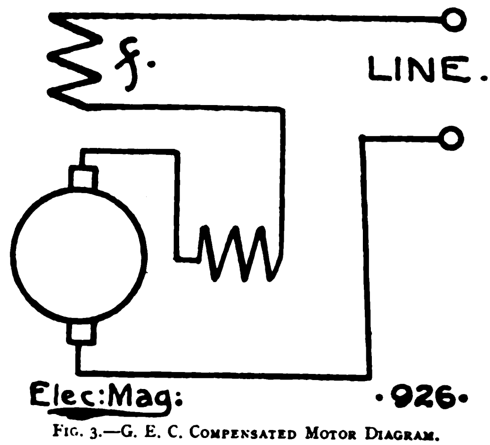


FIG. 3.—G. E. C. COMPENSATED MOTOR DIAGRAM.

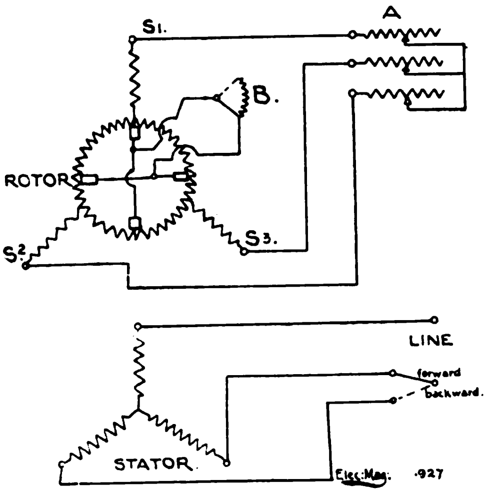


FIG. 4.—FYNN MOTOR DIAGRAM.

the stator serving as field for the direct current service and as induced secondary for the three-phase work. For both services the same liquid starter may be used. The stator winding should preferably be two-phase. This scheme seems, however, to be more complicated than the single-phase arrangement.

The Oerlikon Company has published data on a single-phase series motor of 200 h.p. 650 revs. 15 periods and 250 volts. It has eight projecting poles. Between them eight smaller commutating poles excited by the main current are arranged neutralising the crossfield and the reactance voltage. High iron inductions and equalisers for the multiple armature winding are used. The motor may be equally well worked by direct current. As single-phase motor it has a full-load efficiency of 92 per cent. and a power factor of 94 to 97 per cent. Its weight is 3,000 kg.

The Fynn motor built by the Alioth Company for stationary purposes as well as for lift work is reproduced in Fig. 4. It has an armature with direct-current winding connected to the commutator; to this winding a star connected three-phase winding is added the ends of which lead to three slip-rings S_1 S_2 S_3 (Fig. 4). The motor is started as a repulsion motor and the starting current may be adjusted by the resistance B which is, however, only used for motors about 5 h.p. Then the three-phase resistance A is switched in and gradually short-circuited. The stator has a three-phase winding, two-phase being alternately used for backward and forward motion. The efficiency for a motor of one h.p. is 70 per cent., for 10 h.p. 75 per cent.; the power factor for the same motors being 74 and 82 per cent. The starting current for full-load torque is only 70–80 per cent. of the full-load current. For starting with double torque 1.4–1.6 times the full-load current is necessary. By adding a special exciting winding in the stator shifted by forty-five degrees against the main-field winding, and connected across the commutator terminals the power factor may be raised to above 90 per cent. entailing, however, a corresponding decrease of efficiency.

F. Niethammer

ELECTRICITY AS APPLIED TO AGRICULTURE.

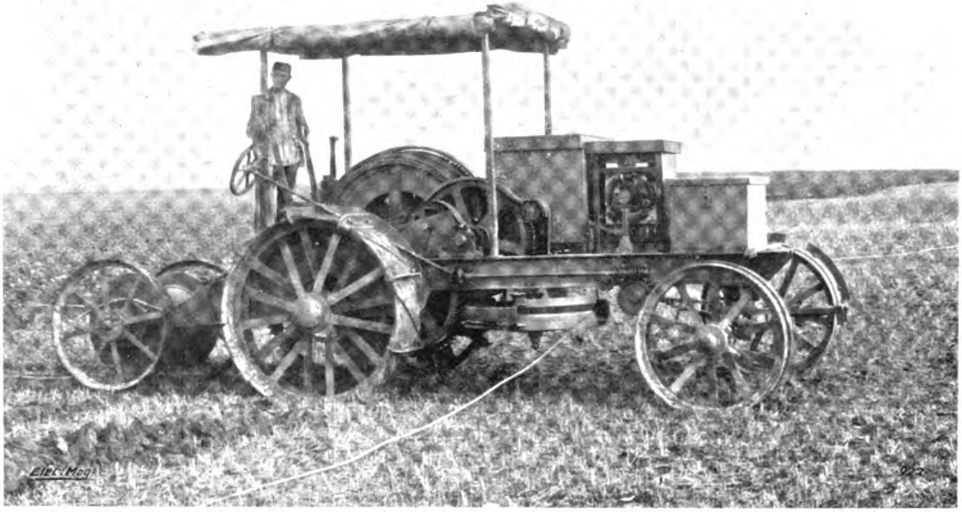
By L. RAMAKERS.

Although electricity has for some time past been used for municipal and industrial purposes, so far it has received but little attention at the hands of agriculture. In countries endowed with natural hydraulic power, usually situated at some distance from the towns, the electricity required for industrial purposes has been transmitted by overhead wires on poles which are as numerous as they are unsightly, over the fields and through the villages without being tapped there. However, of late years, it has been recognised by such villages and small towns that they could advantageously utilise some of the power passing along overhead wires, for lighting purposes. Many localities, even those most remote and situated in the mountains, have passed at a bound from the smoky oil lamp to the electric incandescent light, which is now to be seen not only in the drawing-room of the castle, but also in the farmhouse, the barn, and the stable.

Besides lighting the farmhouse, electricity might well be employed in the various farming operations requiring the aid of motive-power, thus doing away with the hand labour of farm servants and the services of the horse, the latter being better employed for transporting produce than for operating machinery.

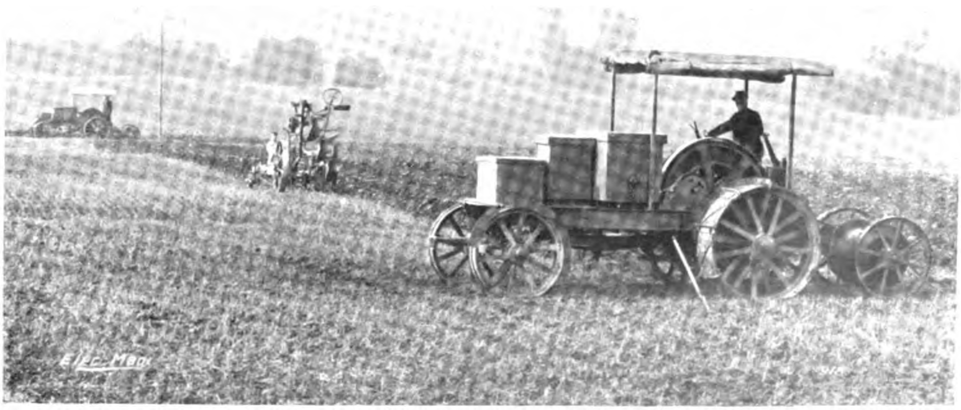
Judiciously employed electricity seems called to create, at a more or less distant date, a veritable revolution, which will greatly improve methods of agriculture, and give rise to a prosperity hitherto unknown. Electricity, it may perhaps be objected, is expensive and not easy to generate, but as there are many methods which can be successfully employed, the large and small consumer can be considered as adequately catered for. The cost of erecting a power-plant is much less in the country than in the town, and the subsequent working expenses are very small in comparison. There is no lack of the requisite sources of energy for the generation of electricity, many being even quite gratuitous. Amongst these latter we may mention the wind which, by means of suitable motors, may be made to drive dynamos charging reserve accumulators, for use when the weather is calm; and then there are waterfalls which are already being turned to account far and wide. Failing these there are steam-engines already in use in agricultural districts, and in connection with other industries more or less indirectly related to agriculture—oil motors, spirit motors, &c.

Electricity can easily be used for many different purposes in agriculture, but pre-eminently for cultivation. In the opinion of M. E. Guarini, who has made a special study of this subject, the new science of electro-culture affords a vast field for progressive movement. This investigator states that the effect of light on plants is due to simple electric phenomena and that, consequently, light can be replaced by electricity; though some effective method of suitably applying electricity has still to be discovered. The possibility of this, has, nevertheless, recently been fully confirmed by the experiments made by Professor Selim Lemstroem who, by electrifying plants at night, has found that the current produced the same effect on these plants as the light of the sun. From experiments made to a slight extent in other countries, it has been found that by electrifying seeds their germination was notably accelerated. For instance some peas treated with electricity germinated in two and a half days instead of in four, haricots in three days instead of in five, barley in two days instead of five. Although the beneficent effects of electricity upon plants has now been established, its method of operation has not yet been thoroughly elucidated. That it is a complex matter we are aware. Electricity electrolyses and decomposes the salts contained in the soil, and forms others which can be more easily assimilated by the plants. It increases vitality and thus favours the exchange of gases between the leaves and the atmosphere, promotes respiration, the fixing of the



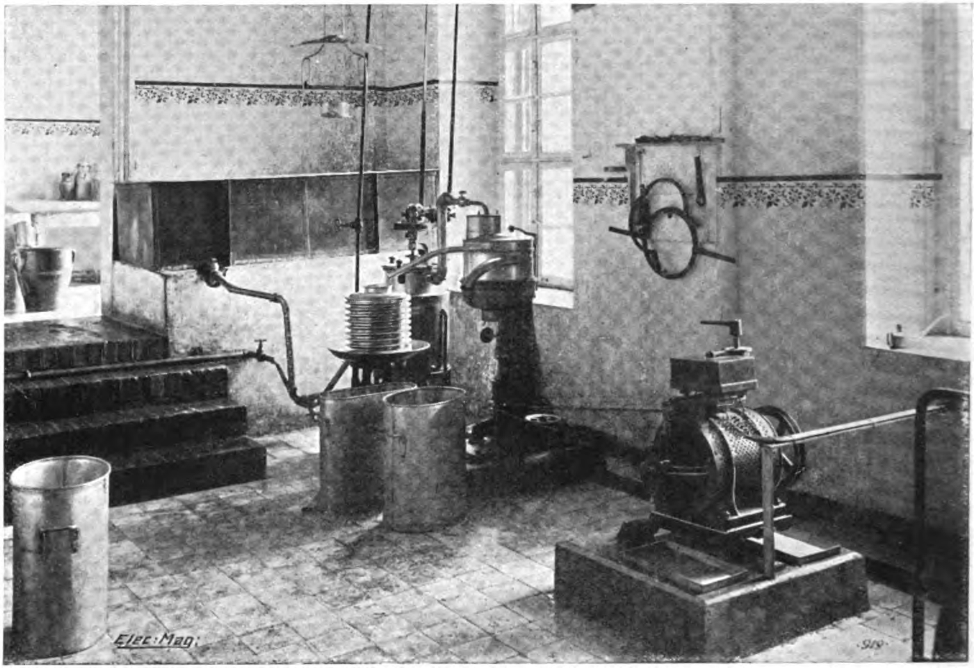
MOTOR-DRIVEN PLOUGH HAULER.

carbon, and the nutrition and multiplication of the cells; finally it influences the circulation of the sap by imparting more energy to the osmose and thus forces the nutritive juices into the capillary vessels in the tissues of the leaf. It is, of course, understood that electro-culture does not obviate the necessity for tilling and manuring the soil. In connection with the former, however, the farmer may also obtain valuable aid from electricity, and, in this connection, we may turn to its more practical application to farming operations.



PLOUGH HAULAGE BY ELECTRIC MOTORS.

(The pole in the distance carries transmission lines.)



MOTOR DRIVING DAIRY MACHINERY.

Tilling the soil with the aid of cattle is expensive; the use of steam-engines is not much cheaper, whilst it is difficult to put into practice. Electric ploughs, however, have been constructed which give excellent results. These ploughs are of two types, one having a single and the other a double motor. Several other models have been constructed but have since been abandoned. The single motor ploughs consist of four parts: first the plough which has usually two series of three, four, five, and even six shares. One series serves for the outward journey and the other for the return. Either the one or the other set is put into action by drawing the plough backwards and forwards between two points. The plough then travels from one side of the field to the other, or, to put it more exactly, from the windlass to the point of support by means of a wire cable. The motive truck carries one or two drums driven by an electro-motor. The point of support is formed by means of a truck fitted with cramp-irons. The motive truck and the truck with the cramp-irons move automatically at each furrow, the extent of their movement varying according to the width of the furrow desired.

The double motor system differs from the above merely in that the cramp-iron truck is replaced by a second motor truck.

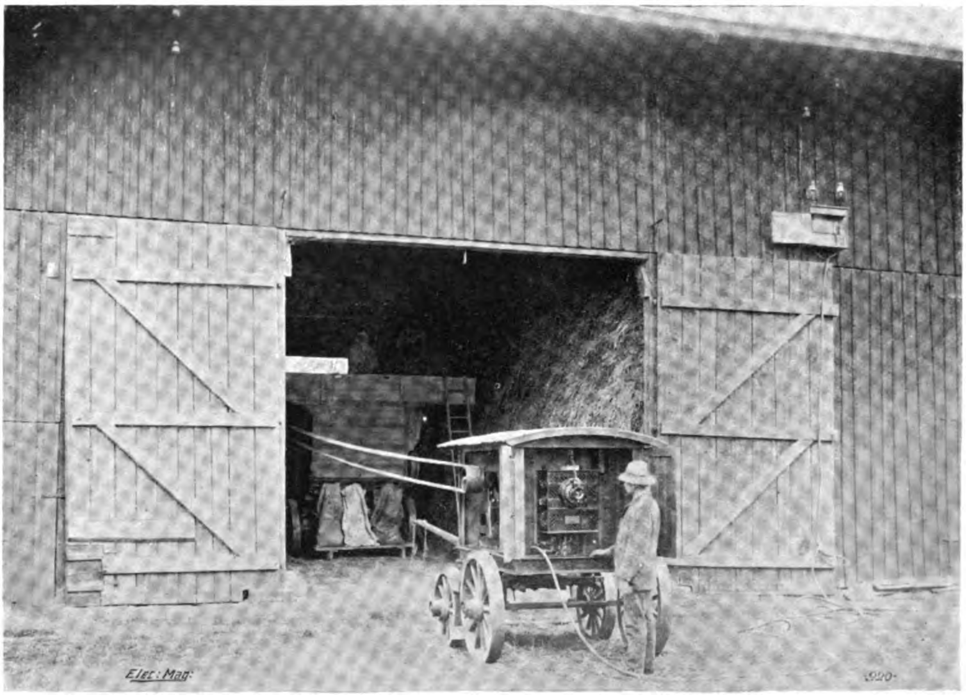
The first system is more suitable for work of slight depth in light soil, the second being used for depths of from 1 ft. to 1ft. 4 ins. in compact ground. These machine ploughs are constructed for a tractive effort of up to 4,400 lbs., and for working speeds of up to 3–5–6 ft. per second: they are fitted with electro-motors of from 40 to 60 h.p. according to the speeds for which they are required. The dimensions of the motors are such that they will produce the maximum tractive effort of 4,400 lbs. with the speeds stated.

Electric tillage is already in use on several large estates in Germany, Austria. Hungary, and Italy, and notably on the farm of Quednau and on the estate of Count Vittorio Asarta at Praforiano. On this latter estate, when experiments were being made, three acres were treated in ten hours. This plant, which has now been increased, is still at work and is

giving very interesting results. With one of these electric installations in Austria 3 acres 50 roods are treated in a working day of ten hours, the depth of the furrows being from $9\frac{3}{4}$–$13\frac{1}{2}$ in. With surface working 5 acres 70 roods can be tilled daily. The average practical speed is from 3 to 5 ft. per second.

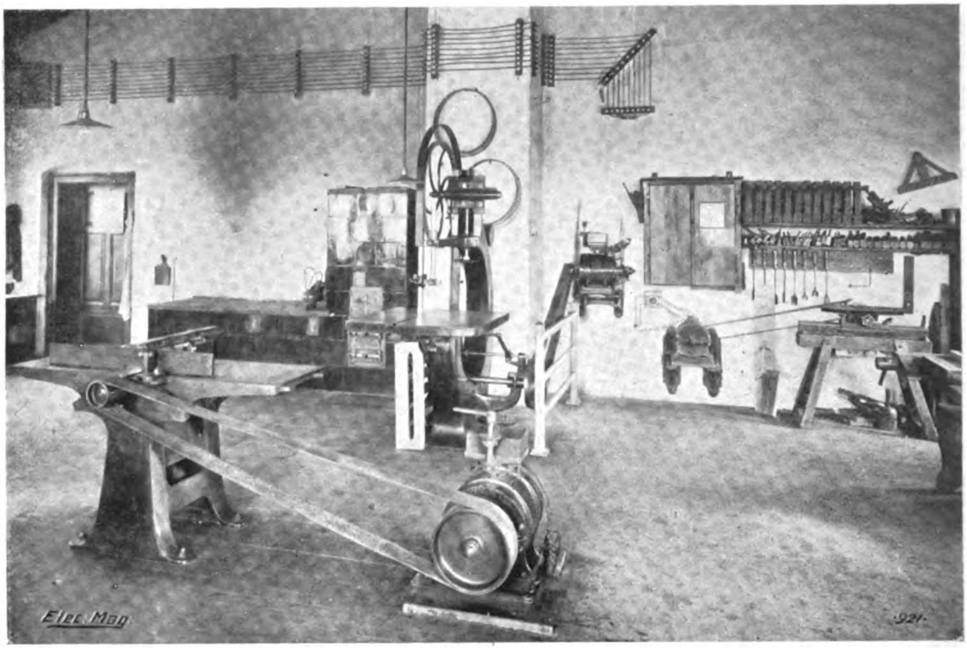
Although electric ploughing enables considerable saving to be effected in comparison with ploughing by the aid of cattle, it requires the investment of a considerable amount of capital, so that it has not much of a future before it as regards small farms. This drawback, however, may be overcome by using electric ploughs on several farms and paying so much for their hire. When used on large estates, such as those mentioned above, directly the crops have ripened, threshing machines, winnowing machines, &c., come into use. All these require motive power, and this can be obtained more cheaply, more conveniently, more easily and with less danger from electric motors than from any other type of machine. However, to make them doubly valuable it should be possible to transport them with ease into the vicinity of the machines they are to operate. To this end they are permanently fixed upon a wooden base if they are of small size, or upon a small waggon if they are too large to be carried by men. When made in this way one or two motors will suffice to deal with work upon a large scale, provided, of course, that they be attended to in an efficient manner to enable them to keep continually at work driving one machine when another is not in use.

As will be seen from our illustrations, which we reproduce by the courtesy of Messrs. Siemens-Schuckert, Berlin, which was one of the very first firms to take up this new branch of electricity, all agricultural machines are adapted to be driven by electricity. Amongst others we may mention — besides threshing machines—chaff cutters, carrot and beetroot cutters, &c., winnowers, centrifugal cream separators, pumps of all kinds, oil-



Threshing Machine Driven under Cover by Portable Motor in the Open.

(Note power lines on side of barn.)



MOTORS DRIVING TOOLS IN SMALL WORKSHOP.

cake crushers, mills of all types, elevators, sheep-shearing machines, churns, separators, fans, grindstones, &c.

Certain machines, such as threshers, &c., require the full output of a 5- to 20-h.p. motor; others, of smaller size, only take from 2 to 3 h.p. and, in this case three or four can be driven by the same motor by the use of a countershaft.

Electro-motors can be very well utilised for all operations requiring power on a large estate. They can even be turned to account in the kitchen, and, on many estates, they are to be found driving coffee mills, sewing machines. Rooms, kitchen utensils, flat irons, &c., are further heated by electricity.

In conclusion it must not be forgotten that a great advantage is to be derived by using electric light on farms because, as it not only obviates all risk from fire provided the wiring has been properly laid, but it also enables work to be undertaken in the open air—a matter of vital importance — when climatic conditions dictate a continuance of operations without delay of any kind.

L. Ramakers

Readers are referred to the World's Electrical Literature Section at the end of the Magazine for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

Coal-Cutting by Electricity.

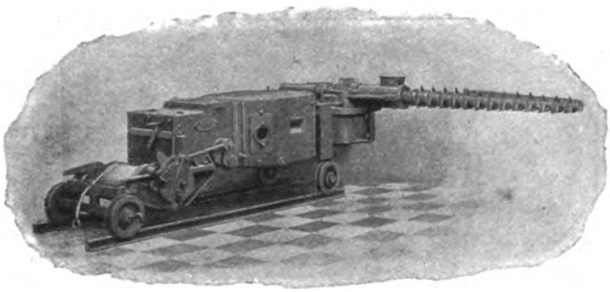
By BENJAMIN TAYLOR.

ONE of the objects of the Royal Commission on coal supplies is to examine into and report upon economies which may be effected in the production, as well as in the consumption, of coal. The engineer is interested in both aspects, but the mining engineer primarily in the extent to which savings can be effected in the winning of coal. One method for economising both in cost and in wastage, and for developing thin and difficult seams, is the employment of electrically driven coal-cutting machinery. The use of coal cutters is, of course, vastly more common in the United States than in Great Britain. Why, it is not easy to say, but probably because of the dearer labour, the craze for speed, and the general atmosphere of machine-work across the Atlantic. The United States is now the largest coal-producer in the world. In 1899 there were 3,125 machines at work, which produced 43,963,935 tons of the total: in 1900 there were 3,907 machines, producing 52,784,523 tons: and in 1901 there were 4,341 machines, producing 57,843,335 tons. That is an average of 13,510 tons per machine. In Great Britain there were in 1901, thirty-four machines producing only 3,044,340 tons of our enormous total. This is an average of only 10,649 tons per machine. Roughly speaking, there are to-day about twelve times as many coal-cutting machines in use in the United States as in the United Kingdom. But the need and the desire for them in this country is increasing, and will increase.

The types of machines mostly in use are the punching, the chain breast and the long-wall machines; and the motive energy is either electricity or compressed air. The long-wall system is more common in Great Britain than in America. By the long-wall system the coal is extracted from a long "face," which is gradually shoved forward, and the earlier machines for this method of mining were not very successful. The purpose of this article is to describe a highly successfu' long-wall machine, appropriately called the Pickquick, which is made by Messrs. Mavor and Coulson, Ltd., Glasgow, and which is coming into very extensive use. This is a bar coal-cutter, and is electrically driven, although, if needed, it can be made for compressed air.

There is now, in this country at any rate, an increased interest in machine mining. Colliery managers realise the advantages of this method of working, and the tendency is towards the adoption of coal-cutters. The number of machines at work is increasing, and a great development of the system is in progress. The shortening of the miner's working day compels the adoption of all means of maintaining or increasing the output, and the most valuable aid to this end is machine holing.

In the coal-fields of Great Britain there is undoubtedly wide scope for mechanical coal-cutters. Many machines of proved capacity are now on the market, and are available to meet the demands of different conditions. In thick seams, the value of coal-cutters in reducing the cost of production and increasing the output has been abundantly demonstrated. In medium seams, especially where hard holing is encountered, the advantages of machine cutting are widely appreciated. For thin



PICKQUICK COAL-CUTTER RAISED ON WHEEL BRACKETS FOR TOP HOLING.

seams, there is no economical alternative to machine mining. If the holing is in coal the machine makes less "small," and if the holing is made in hard strata the hand-pick miner must give place to the machine. The long-wall method of working, common in Britain, is specially suited for machine mining.

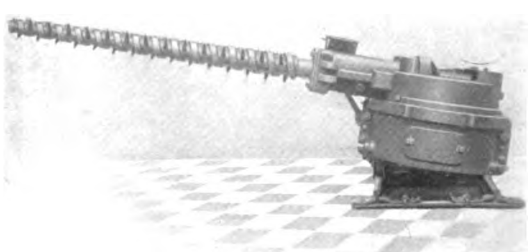
The economies effected by machine mining are thus summarised: (1) The cost of holing is reduced by the large increase of output per man employed; (2) A large output is obtained from a relatively small face, and the extent and cost of maintenance of roads is reduced; (3) The cost of timbering is reduced, and the straight and rapid advance of the face facilitates the breaking away of the coal; (4) The use of explosives is reduced and may be frequently abolished by machine holing; (5) The percentage of slack is reduced and the sale price of the coal is increased; (6) There is greater safety to the miner, as the machine does the most dangerous part of the miner's work, and the systematic timbering imposed by machine holing reduces falls at the face, and diminishes the number of accidents and compensation claims. The results obtained in the various districts prove that some modern coal-cutters do meet the requirements, and do realise substantial economies.

Coal-cutting machines require comparatively simple attention. It is upon the management of the mine in relation to the output required from the coal-cutter that success depends. A perfect coal-cutter is helpless if the proper conditions are not provided, in many cases involving considerable modification of existing methods of management. The successful operation of coal-cutters depends upon close and persistent supervision, and good results are due mainly to the active and intelligent interest of the manager. A maximum output cannot be obtained immediately a coal-cutter is started. The conditions in different seams vary widely, and experience has to determine the most economical length of face to work, the depth to be undercut, the thickness of the cut, the shape of the cutter points, the relation of speed of cutter points to the rate of feed, &c.

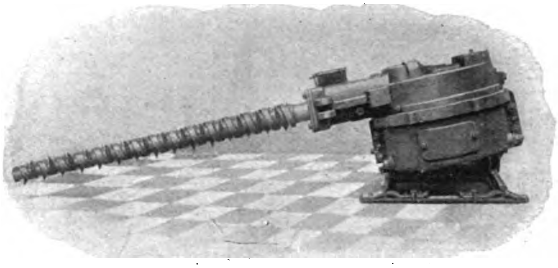
It is to be remembered that, although mechanical coal-cutters have been in use in this country for many years, until recently they have been dependent upon compressed air for their motive power. The inconvenience and low efficiency of this mode of transmitting power caused slow progress in machine cutting, but the electric motor opened a new era. The driving of a coal-cutter is probably the most severe task to which an electric motor can be applied, but its conditions have been recognised and met, and the electrical parts of a coal-cutter are now the last to give trouble. Compressed-air driven coal-cutters are now only useful in mines where the carrying of electric cables into the workings is inadmissible. Direct current is the best adapted for driving coal-cutters. When the adoption of alternating current is determined by other considerations, a low periodicity, not exceeding thirty cycles per second, should be used, as the limitations are incompatible with the best design in alternating-current motors for higher periodicities.

The Pickquick electric bar long-wall coal-cutter avoids old-time defects and weaknesses, of which a few illustrations are here given. This machine is the outcome of many years' experience and of close and persistent application to the problem of coal-cutting. It has practically been evolved at the coal face, and every detail has been perfected by careful modification in design.

This coal-cutter is made in three sizes. The rate in lineal inches per minute at which



END VIEW OF CUTTER WITH BAR RAISED.



PICKQUICK COAL-CUTTER, BAR TILTED DOWN.

the respective machines will cut depends on the hardness of the material, and on the depth of holing desired. A number of these machines are holing in very hard material, and, in some cases, where the hardness precludes hand picking. The machine will hole in any material that the best of steel cutters will withstand. The motors are designed to ensure smoothness and steadiness of working of the whole machine, which is free from the severe shocks and stresses due to jamming and consequent overloading that attend the use of machines of the disc type. This feature peculiarly adapts it for use where alternating current must be employed. The small starting torque required permits the use of the simple squirrel-cage rotor with ample clearance between the rotor and the stator. The absence of jamming avoids the necessity for large breakdown capacity and heavy currents in the line, with consequent disturbance to other apparatus supplied from the same generators. The motors are built to withstand the roughest treatment, and are enclosed to be perfectly flame-tight, and are effectually protected from dust and external damage.

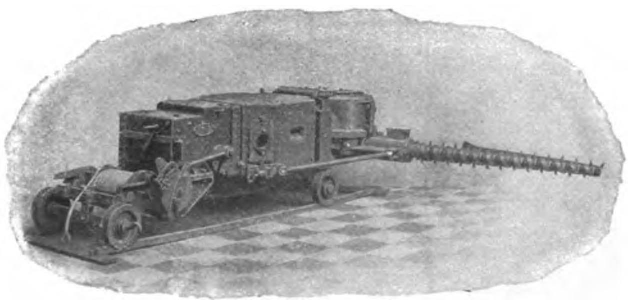
The working parts of the machine are few in number, and, therefore, little liable to derangement; and the accessory bolts, nuts, &c., are reduced to a minimum. Complete protection of the working parts is combined with convenient means of access for internal inspection, and for the ready detachment and refitting of parts. As the gear is machine-cut and is enclosed in an oil-bath, it makes little noise. There are no bearings or rubbing surfaces under the coal, where dust and dirt subject them to excessive wear.

A cutter bar is simpler than a disc or chain, and permits of the secure and rapid fixing, and simultaneous and easy inspection and changing of all the cutters. The cutters are of a simple make, and can be sharpened and hardened by any blacksmith. The bar, on being swung round in a horizontal plane, cuts itself into the face. The machine will cut either backwards or forwards, and the bar can be used at either side. Besides cutting either on the pavement or at the roof, or at any intermediate part, the bar may be tilted to suit the rise or dip of the seam, and, while working, can be raised or lowered at will, and the holing thus made in the best position. Small hitches, or faults, undulating pavements, or ironstone balls, involve little interruption to the continuity of the cutting. When working in a top holing, the bar does not distribute the cuttings over the machine, and in any position the bar-machine raises little dust. The bar being always close to the solid, cannot be choked or jammed by the coal coming down upon it.

It is claimed for the Pickquick that less power is required per square yard undercut than by any other coal-cutter, and the uniformity in power absorbed demonstrates how smoothly and steadily the bar-machine works, and accounts for the immunity from motor troubles.

The coal is moved round and the waste is small, as the loose coal is not dragged down and broken up. Sprags may be set 18 ins. from the bar and solid coal (as against 5 ft. to 6 ft. with disc machines), and this prevents the coal from falling prematurely.

For holing in coal the cutters are fixed in the bottom of the thread of the cutter bar, and their points are adjusted to minimum diameter, giving average thickness of cut of 4 ins., to 5½ in., according to the length of bar. A thinner cut is claimed for some of the disc machines, but the disc cutters tearing round in the holing, drag down and break up coal which is already undercut, while the bar, being always close to the solid, leaves behind a clean-cut slot. In fireclay bands, where it is desired to destroy the material, the width of cut can be increased to 7 ins. or 9 ins. by inserting the cutters in the top of the thread, and the wider slot gives greater freedom for the coal to drop.



CUTTER RAISED ON WHEEL BRACKETS FOR INTERMEDIATE HOLING

The 5,000-h.p. Turbo-Alternator at Frankfort.

By E. GUARINI

THE central station at Frankfort-on-the-Maine, Germany, was built some ten years ago, and was designed for an aggregate capacity of 9,000 h.p., including four 750-h.p. steam generators and four 1,500-h.p. sets. At the end of 1901 connections had been made to supply over 14,000 kw. between power and lighting, and to meet this demand a 4,000–5,000-h.p. Brown-Boveri-Parsons' turbo alternator was put down, and started recently. This new generating unit was made and installed by Messrs. Brown, Boveri and Co., Ltd. of Baden, who are also the makers of the whole of the electrical portion of the plant.

The turbine is designed to run at 1,360 r.p.m., with a steam pressure of 13 atm., and 300° C. superheat. The single-phase alternator direct coupled to the turbine has an output of 2,600 kw., the tension being 3,000 volts, and the power factor 0.8.

The following results have been obtained from tests made with this turbine under ordinary working conditions.

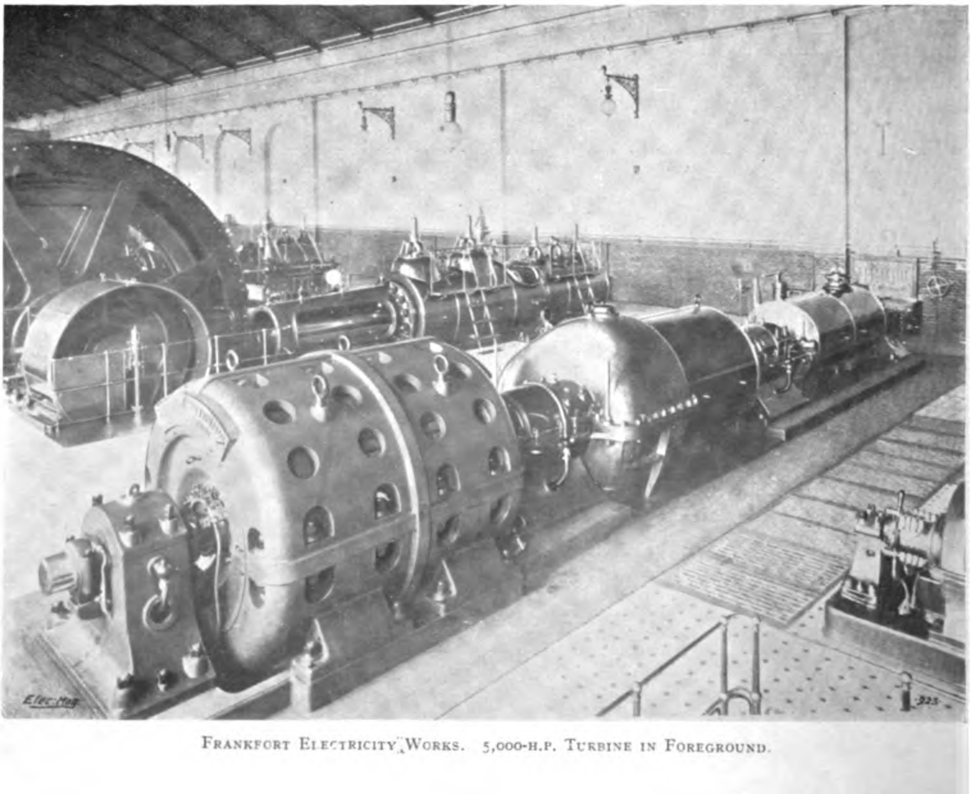
These tests were carried out by the engineers of the Frankfort Electricity

Steam Pressure.	Temperature of Steam at Turbine Stop Valve.	Load in Kw.	Vacuum in Percentage.	Steam Consumption—lbs. per Kw. Hour.	Steam Consumption—lbs. per I.h.p. Hour.
12.63	298 C.	1,945	93.2	15.8	9.9
12.8	295° C.	2,518	91.8	15.6	9.45
10.6	312° C.	2,995	90.0	14.7	9.0

Works. It will be noted that this turbine could give a normal output of 5,000 h.p. corresponding to a terminal output of 3,600 kw. If the output of this machine on the above-mentioned tests had been increased to 3,600 kw., and the vacuum raised to 94 per cent., the turbine would have been much more economical, and would have given the following results:

Steam pressure	10.6
Temperature of steam at turbine stop valve . . .	312° C.
Load in kw.	3,600
Vacuum in percentage . .	94
Steam consumption per kw. hour	13.3
Steam consumption per i.h.p. hour	8.35

The steam consumption of the turbine with an effective pressure of 12.8 atm., 300° C. superheat and a load of 2,600 kw. was guaranteed not to exceed 15.8 lbs. per kw.



FRANKFORT ELECTRICITY WORKS. 5,000-H.P. TURBINE IN FOREGROUND.

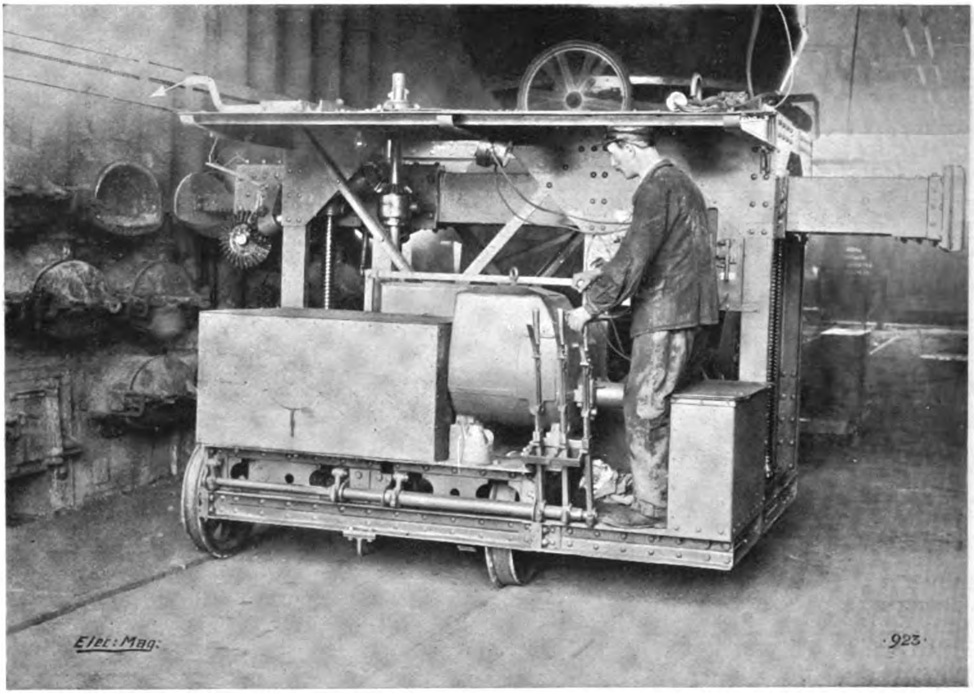
hour. From the results obtained it is plain that the steam consumption is better than what was guaranteed, and the test shows that the turbine runs at least as economically as the best steam-engines of the same output. If we moreover consider the great economy in lubricating oil with the turbine, lighter foundations and building expenses, one can easily understand how much ahead of the steam-engine the steam turbine already is, not only from a technical point of view, but also as far as economy of installation and working expenses are concerned. It was the intention of the Supply Company to change the alternator in course of time from single to three-phase with an increase in output, *i.e.*, 3,200 kw. as a three-phase. The turbine which runs to-day as a 4,000-h.p. machine was, accordingly, designed so as to easily give 5,000 h.p. if necessary.

The simple design of the turbine and the accessibility to the various parts render attendance much easier than is the case with the steam-engine. All internal parts can be easily got at, for, on loosening a few nuts, the upper part of the turbine cylinder can be removed in a short time, thus exposing to view the inside of the machine. Owing to the exclusively rotary motion of the turbine as compared with the reciprocating action of the steam-engine, and to the complete absence of irregular axial thrust, the weight on the bearings is very small, their friction is also reduced to a minimum by the aid of forced lubrication. The oil is made to circulate from a tank to a cooling device, consisting of a worm through which the oil passes, the worm being in contact with cold water, and from the cooling device to the bearings and back again to the tank. This circulation is attained by means of a small pump driven from the shaft of the turbine, and keeps all the bearings flushed with oil, which is under a pressure of 22 lbs. per sq. in. The films thus interposed between shaft and bearings form a self-centring elastic cushion. By these means very little oil is used and none wasted, the consumption being quite small as compared with that of steam-engines. It will be noted that as there are no parts in contact with steam, and at the same time subject to friction, no cylinder oil whatever is needed, while, with steam-engines, especially with highly superheated steam, expensive cylinder oil is necessary, and, moreover, this oil mixes with the steam. The oil consumption of the 5,000-h.p. turbine scarcely attains half a pound per hour. As no lubricant is used in the cylinders the exhaust steam is entirely free from oil, and other impurities, and the condensed water can, therefore, be pumped again directly into the boiler without the usual trouble of filtering. Another advantage that the turbine possesses over steam-engines is the rapidity with which it can be started, the warming up of its cylinders not requiring more than ten or fifteen minutes. The turbine is entirely and promptly controlled by its governor. The steam passing from one end to the other of the turbine in the fraction of a second, the link motion of the throttle valve tells directly on the speed of the turbine. Practice has shown that the steam turbine can be regulated in a way much superior and more accurately than reciprocating steam - engines which generally rotate several times before a change in the link motions makes itself felt on the speed of the machine. With the steam turbine a load of 2,600 kw. can be suddenly thrown on or off, with only a 6 per cent. momentary variation in speed. Though steam is admitted to the turbine by a series of gusts, the co-efficient of irregularity of the machine is very small and hardly ascertainable. The parallel working of the turbo-alternator with the alternators coupled to the reciprocating steam-engines has never given any trouble.

The special construction of the rotating magnet field, which is designed very similar to the rotor of a synchronous motor, an arrangement which has got many advantages both from an electrical and mechanical point of view, partly helps the machine to attain such satisfactory parallel running.

Electrical Retort-Charging Machines.

ELECTRIC charging machines are now employed for gas coke - ovens and also in modern steel plants for charging Siemens - Martin open - hearth furnaces both in America and in Europe, resulting in the saving of a great deal of labour and economy of operation. The electrically driven machines for removing the coke as well as for charging the retort move along the tracks provided in front of the gas retorts and receive current from overhead conductors or trolley wires. The coal is deposited at the storage pile and removed from the same by cranes and cars, and is dumped into the hopper of the charging machine. This is then moved along the track to the retorts, the motors being controlled by one of three levers in front of the operator. These machines were designed for use with long horizontal retorts of 20 ft. or more in length. The hopper or feeding - box is arranged with four compartments holding about four tons of coal. At the bottom of the hopper or feeding - box there are screw conveyors,



Electric Charging Machine for Gas Retorts.

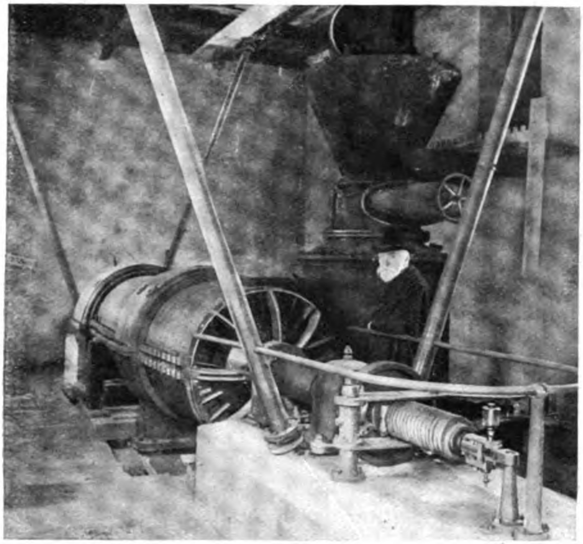
and the coal is carried by them to the centre in a constant stream through a telescopic pipe to a turbine provided with fine steel blades. This turbine is operated by an electric motor at a speed varying from 430 r.p.m. to 230 r.p.m., the coal being carried in a steady stream through a horizontal pipe or channel into the retort. To ensure a proper distribution of the coal, a higher speed is utilised when beginning the charge, as a greater force is required to carry the coal to the ends of the retort, which is 19 ft. long, than to deposit it at the entrance, and the speed is gradually reduced to the latter amount at the end of the charging.

The speed regulation during the charging is rendered absolutely automatic by rheostats connected by gearing to a time commutator the diameters of the gearing being in proper ratio for a given charge of coal and a given time. The time commutator and rheostats are connected so that the movements are asynchronous, the weight and duration of the charge determining the ratio of the three toothed wheels connecting the rheostat and commutator. For uniformly distributing 900 lbs. of coal in ten seconds in a retort 19 ft. long the power required for one motor is about 12 h.p. and for the other about 18 h.p.

All of the operations of the charging car are controlled by the operator by three levers to be seen in the illustration. The pipe or channel connecting the mouth of the retort to the turbine includes two parts, one movable and the other fixed. There are three electric motors, one operating at 900 r.p.m. and moving the turbine up or down for the distribution of the coal in the retorts at various heights. This motor is mounted upon a movable frame which supports the turbine. The power of the two motors varies according to the length of the charge, electric power being also utilised for moving the machine on the track, for operating the turbine in distributing the coal, for raising and lowering the turbine, and for operating the four distributing screws. F. C. P.

GAS TURBINES.

In our editorial notes last month we promised to give particulars and an illustration of a gas turbine which had been experimented with. A form of this engine has been brought out by a German Syndicate, the Gas-Turbinen-Gesellschaft of Berlin-Charlottenburg. Attempts at constructing a gas turbine have had for their objects the combining the individual advantages of the gas-engine and the steam turbine. The gas turbine in question is of a date anterior to any successful steam turbines. It was



General View of Stolze Gas Turbine.

invented by Dr. Stolze in 1873, but the peculiar conditions of patent regulations in Prussia at that time resulted in the patent being refused. The inventor, being engaged for a number of years in other work, was prevented for some time from taking up his original idea, but some years ago was induced to do so by the continued success with steam turbines, and as a matter of course was readily granted the patent applied for. The underlying principle consists in compressing atmospheric air to a moderate pressure, say $1\frac{1}{2}$ atmos. above atmospheric pressure. and in heating afterwards this compressed air so as to cause it to assume a 2- or $2\frac{1}{2}$-fold volume with the same pressure, after which the air is allowed to expand down again to atmospheric pressure. The excess of work performed over the absorbed energy is thus due to the increase in volume resulting from the heating.

Two sets of turbines of different design are mounted on a common axle. One of these serves as air compressor, while the other drives the shaft by means of the heated air. Either set consists of several rows of guiding vanes, fitted to the engine casing and of several rows of running vanes of a corresponding design, fitted to a common rotating cone turning with the shaft. One of these turbines draws in the fresh air, compressing it to a given pressure through a pre-heater (heated with exhaust gases) and driving the greater part of it into a chamber lined with fireproof material. The smaller part is conveyed beneath the grate of a producer, where it serves to gasify a convenient fuel. The gas thus formed penetrates into the chamber alluded to, to be burnt there by the compressed air in suitable burners to carbonic acid and water vapour, while evolving large amounts of heat. These gases next penetrate into the second turbine system, where they are allowed to expand in traversing the various steps, thus yielding useful work. The process is thus analogous to the cycle performed in all combustion engines, consisting of a suction of air, followed by the compression of the same, the mixing with fuel, combustion, expansion, and subsequent exhaustion. A distinguishing feature is, however, that the mixing takes place after compression, and the combustion at constant pressure.

The efficiency of the motor will probably be so improved as to become more satisfactory than with any existing type of motor. The gas turbine permits of approaching the Carnot cycle more closely than with any other design of motor. A large-sized engine of an effective output of 200 h.p. is nearing completion in Berlin. Any kind of gas can obviously be used instead of producer gas, as supposed in the above, and carbonated air or benzine, alcohol, or petrol vapours are also quite suitable for the operation of this turbine.

CALCULATION OF POWER TRANSMISSION COST.

It is of the utmost importance that the limiting pressures and economics of power transmission and their relation to the capital and expenditure of an undertaking, be recognised, and this recognition should not admit of deviations one way or the other. Further, it can be readily understood that any formula which will allow of the accurate statement of all such limitations must be of importance. Professor R. H. Smith, in the *Light Railway and Tramway Journal* (November), puts forward figures and calculations which have every appearance of permanent value. His deductions occupy some little space in our contemporary, but are best summed up by his concluding paragraph.

"The gist of the whole argument may be put shortly in this way: Principles of economy, long since stated in outline by Lord Kelvin, indicate a certain current density and a certain fall of potential per unit length as those which reduce to a minimum the sum of capital charges and running costs in the transmission of power by electric current. With such adjustment the sum of these costs is proportional to the power

delivered, and to the distance through which it is transmitted, and also inversely to the electric tension used. The power to be delivered and the distance are specified and are outside the control of the designer of the transmission. The voltage wanted at the final point of delivery is similarly specified and beyond his control. He can cheapen the cost of transmission by transmitting at higher tension than the required final tension provided the saving in this way is not overbalanced by the additional losses of power by the inefficiency of the transformers and converters which must be introduced to bring down his high-tension of transmission to the necessary low working tension, and by the additional capital charges upon this extra reducing plant. Adding these extra power losses and capital charges to those of the high-tension transmission *per se*, there is obtained the total cost of the high-tension-cum-conversion delivery of power from the central station to the low-tension line. This total is found to be proportional to the power required, and its other factor is the sum of a constant and a term proportional to the distance directly and to the transmission high-tension inversely. Comparing this total with the similar costs of transmitting at the working low-tension without conversion, the power required to be delivered cancels out as a factor common to both. If the low tension be written e and the high-tension E and the distance L, the comparison then takes the form (Low-tension Transmission Constant) $\times \frac{L}{e}$ greater or less than (Sub-station Conversion Constant) + (High-tension Transmission Constant) $\times \frac{L}{E}$.

"If it be greater, then it is economic to incur the extra expenses of the sub-station, and *vice versa*. This criterion may be expressed as a limit of length beyond which, for specified e and E, it is more economic to use the high-tension E with sub-stations. Or it may be expressed as a limit of high tension above which the transmission voltage must lie to justify the expenditure on and in sub-stations for specified distance and specified low-working voltage. The constants vary with local conditions. Using average values, the foregoing tables are calculated showing these limits of distance and of high-transmission voltage for the two working voltages 500 and 3,000 delivered. The 500 corresponds to tramway working, and the 3,000 to the modern system of railway working. For 500 working voltage the critical distance is about seventeen miles for transmission voltage no more than 1,000 volts; shortens rapidly to about 2½ miles if E be raised to between 4,000 and 5,000 voltage; and then shortens very slowly towards the limit two miles for extremely high-transmission tension. For 3,000 working voltage, the critical distance decreases rapidly from fifty miles for E = 6,000 volts to about sixteen miles for E = 10,000 and about ten miles for E = 20,000. Above this E it shortens very slowly towards the limit 7½ miles. These results are, however, subject to considerable modification in accordance with local variations of capital costs of land and buildings, price of coal, and rates of wages."

POWER NOTES.

Distribution of Electrical Energy.

The following is a portion of the official abstract of Mr. J. F. C. Snell's paper on the above subject, read before the Institution of Civil Engineers, November 22. The author describes the various systems by which electricity is at present distributed. After dealing with the limits of pressure as defined by the Board of Trade, and the results of the work of the Engineering Standards Committee in settling upon standard periodicities, the systems of supply are more thoroughly criticised, and the single-phase system is set aside as being inapplicable for general supply, as is also the direct-current high-tension system. The author is of opinion that the distributing systems which are likely to be adopted in the future are:

(1) Direct-current, two- or three-wire, for small districts.

(2) Single-phase high-tension for railways.

(3) Two-phase high-tension generation and low-tension distribution (for existing single-phase systems of general supply).

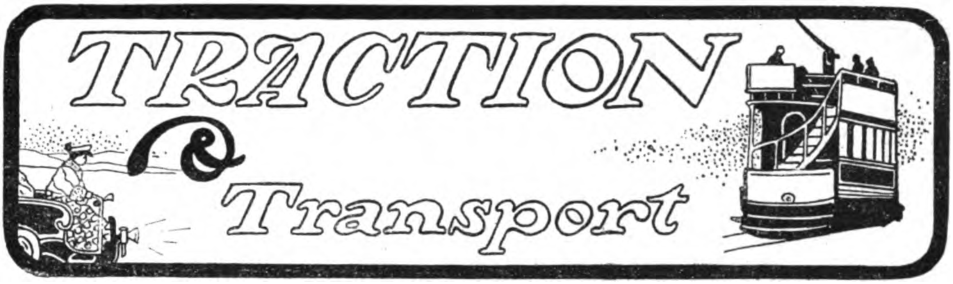
(4) Three-phase high-tension generation and direct-current low-tension distribution (for existing direct-current systems in large districts, and for railways of short length).

(5) Three-phase high-tension generation and low-tension three-phase or six-phase distribution (for entirely new and large districts).

Diagrams accompanying the paper demonstrate the economical radii of supply by direct current at 500 volts for different loads transmitted and by the high-tension sub-station method, the result being that above the under mentioned distances the high-tension method is more economical, viz.:

Kilowatts.	Economical radius.
250	1.6 mile
500	1.25 ,,
1,000	1.05 ,,

With regard to the effect of storage at sub-stations, the author believes that storage will be more largely resorted to in the future; and figures are given in support of this view. He then proceeds to discuss the economical limit of pressure for high-tension supply by underground cables; and gives curves to show that for general purposes, in Great Britain, 6,600 volts is, approximately, the economical pressure. The effect of the cost of insulation of extra-high-tension cables is also discussed. The Paper next deals with the cost of overhead transmission of high-tension currents, and reasons for fixing upon a pressure of 20,000 volts in this country are given.



A classified list of Traction and Transport articles will be found in the World's Electrical Literature section at end of magazine.

ELECTRIC TRACTION FOR RAILWAYS.

VIII. The Efficiency of Direct-Current Driving.

By W. M. MORDEY, M.Inst.C.E., Vice-Pres.I.E.E.

(*Continued from page* 480.)

Central London Railway.

THE main electrical difference between the Central London and the Liverpool line is that for the former generation and transmission are by high tension three-phase alternate-current, with rotary transformers at sub-stations delivering direct current to the trains. So far as the trains are concerned, the two lines are alike in principle, electrically. They are very similar also in length, the Central London Railway being six miles long with thirteen stations, averaging 875 yards apart, while at Liverpool, as stated in the last article, the length is six and a half miles with seventeen stations, averaging 620 yards apart. The train-miles run on the Central London are about 24 per cent. more than on the Liverpool line.

From the latest available published returns for the Central London Railway, viz., those for the last six months of 1902, the following figures are taken or deduced:

Train-miles	632,428
Ton-miles	86,347,000
Units supplied to trains	5,513,258
Units per train-mile	8.72
Units per ton-mile	0.064
Weight of train	137 tons

If the train friction be assumed to be the same as was taken for Liverpool, viz., 15 lbs. per ton, the energy necessary to overcome that friction works out at 4.11 units per train mile; the overall locomotive efficiency is therefore $\frac{4.11}{8.72} =$ 47 per cent. This is more than double the Liverpool efficiency.

There are several circumstances which favourably affect the Central London and explain the efficiency of driving being higher than on the Liverpool line. A consideration of these circumstances will be found to justify the statement made in a previous article, that the low efficiency of the latter line is not due to any cause for which the organisation can be blamed. To put it another way, if the generating plant and rolling-stock of the Liverpool line were applied to the Central London Railway and run under the Central London Railway conditions as to acceleration and speed, it would

show a result as regards efficiency as high as that attained on the latter line.

The higher efficiency is accounted for by the following circumstances: As compared with Liverpool, the acceleration is much lower—less than half that at Liverpool—the average and maximum speeds are much lower, the runs are longer, allowing of a considerable distance being run by coasting without current (approximately about two-thirds of the total distance, whereas at Liverpool the current is on for four-fifths of the run), efficient starting and stopping are greatly helped by the grading of the line. The Liverpool line presents a very difficult problem, one which particularly brings out the defects of the constant e.m.f. direct-current system. The shortness of the runs and the need for high average speed necessitate each run being divided into two parts, both very unfavourable to economy, viz., the severe acceleration period, followed immediately by a still more severe braking period. During the first part energy is stored up in the train, and then instead of being used up by coasting or by some method of regeneration or return, it is wasted in frictional braking.

The best and simplest way to obtain more favourable results in the use of energy is to adopt the "switchback" principle, and arrange the line so that the stations are on the tops of hills, thus aiding acceleration by always starting down hill, and slowing naturally by going up hill, without the need for any large expenditure in frictional braking.

The switchback railways used for amusement afford a very instructive lesson in traction economy. High acceleration is obtained on the down-grades and economical braking on the up-grades, with only the small expenditure of energy by manual labour to make up for the loss in friction. This is switchbacking *in excelsis*. It is not intended to suggest—except as a suitable subject fer the pencil of Mr. E. T. Reed of *Punch*—that the Central London Railway should be run on this principle. That line has probably adopted the principle as far as it is safe to do so, and with marked results on the economy of its working.

The profiles of the Up and Down lines are shown by Fig. 1.*

It will be noticed that each station is on a hill, the incline on the starting side being twice as steep as that on the stopping side, this difference being intended to avoid difficulties in case of a train having to stop on signals. The starting or descending grade at most of the stations is 1 in 30 for 300 ft., the average, however, being only 240 ft. The stopping or ascending grades are 1 in 60.

Fig. 2 is a diagram calculated by Mr. Parshall to represent the conditions of

* The figures used in this article are taken from some very interesting and complete articles by Parshall, Parry, and Casson, in *Traction and Transmission*, 1903, in which very full and clear explanations are given of the principles followed by Mr. Parshall in carrying out the electrical equipment of the railway.

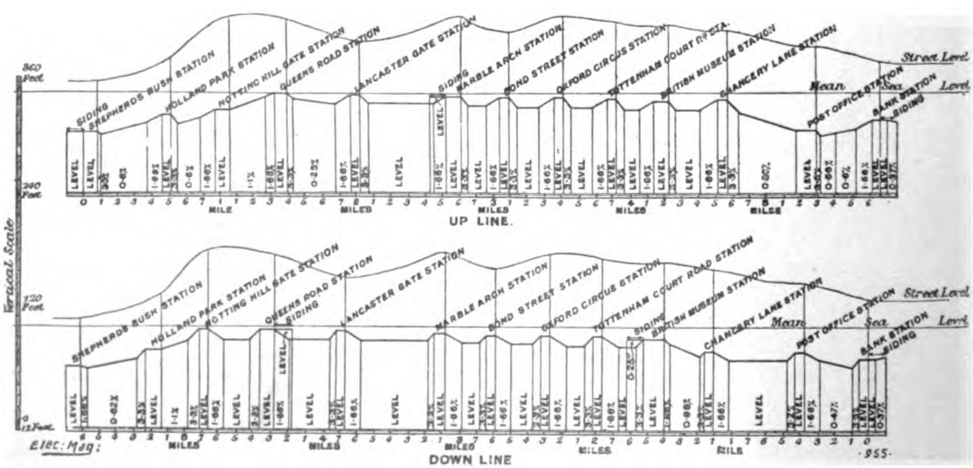


FIG. 1.—CENTRAL LONDON RAILWAY. PROFILES OF UP AND DOWN LINES.

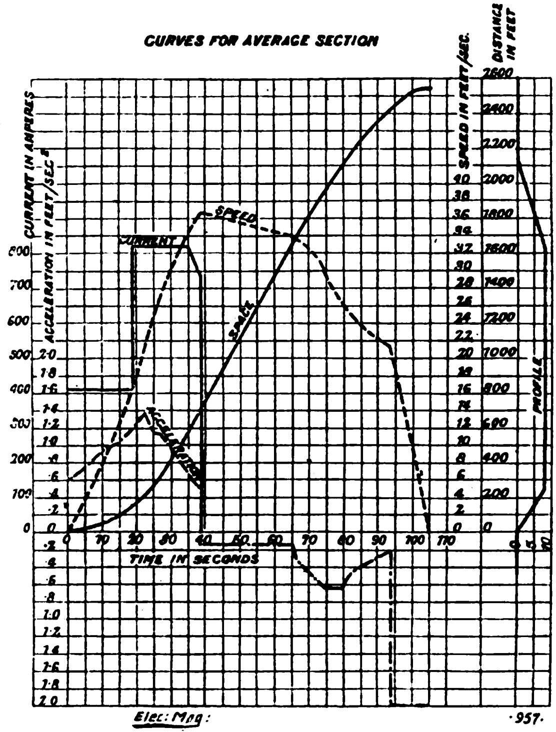


FIG. 2.—CENTRAL LONDON RAILWAY.

an average section, and by comparison with the actual results got at Liverpool,* it well illustrates the different conditions of the two lines.

First, as to acceleration: the maximum acceleration is only 1.4 ft. per second per second as against 4.2 at Liverpool and four-sevenths even of this lower acceleration is the net effect due to the gradient, so that the demand on the station is small, as is evident from the current which, by the diagram is about 820 amperes at 500 volts, or 410 kw. of "maximum demand," or 2.8 kw. per ton for the 147-ton train. Compare this with Liverpool where the "maximum demand" (due to higher acceleration and absence of any helping gradient) is nearly twice as much, the 46.3-ton train taking 600 amperes at 400 volts or 240 kw. = 5.2 kw. per ton (or 6.5 kw. per ton at 500 volts).

* *The Electrical Magazine*, vol. ii., No. 5, November 1904, p. 478, Fig. 1.

The maximum speed in the Central London Railway diagram is about 36 ft. per second, or 24.5 miles an hour, compared with about 31.5 miles an hour at Liverpool. The long period of coasting without current will be noticed, together with the indication that the speed has come down to about 14.3 miles an hour before the brakes are applied, whereas at Liverpool the brakes are applied at full speed, and there is no coasting except during the very short braking period. The negative acceleration or retardation is only two feet per second during braking, or about one-half of the rate of slowing attained at Liverpool, where frictional braking has to be used without any help from the gradient.

Fig. 3 shows the result of a test on a gearless locomotive with a seven-car train, the gearless locomotive running a distance on the flat equal to the average length between stations on the Central London Railway, the total load being 148 tons. The energy consumption works out 53.5 watt-hours per ton-mile, the actual results of working, according to the figures given above, show 64 watt-hours per ton-mile. The excess over the test result, in spite of

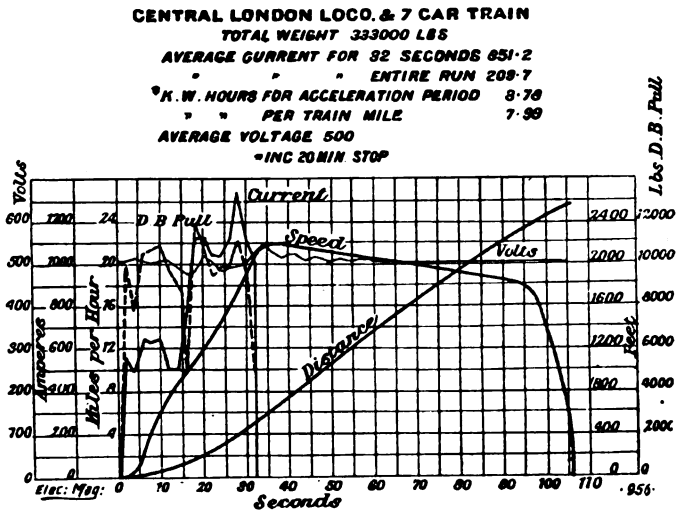


FIG. 3.

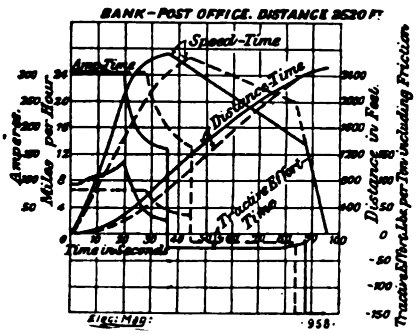


FIG. 4.—EFFECT OF SWITCHBACK PROFILE ON CENTRAL LONDON RAILWAY.

the effect of grading, is no doubt due to difficulties of getting regular working results to come up to test results, a matter on which the Liverpool line seems to have been more successful.

Fig. 4 is one of twelve calculated diagrams given in the "Traction and Transmission" articles, to show the effect of the grading for various sections of the line. The dotted lines represent the conditions that would obtain on a level line, the full lines represent the Central London Railway conditions. The saving due to the switchback profile is very perceptible.

It was stated above that the efficiency on the Central London Railway trains was 47 per cent., that is to say, the energy used per train-mile was 8.72 units, whereas 4.11 units should suffice to drive the trains if there were no losses other than the frictional losses of the train.

The author's estimate of 47 per cent. is very closely confirmed by figures to be deduced from the description to which we are already so much indebted and from the published working results of the line. From these sources it is possible to construct an Energy Account in which the consumption is given in units per train mile and in percentages, the Liverpool percentages being added, from the previous article. The Central London Railway values are based on returns from the last six months of 1902, when the gearless locomotives were in use. The later motor-carriage trains do not seem to have very materially reduced the consumption, but on that point we must wait for further information. This Energy Account is very significant. The Central London Railway is probably the most carefully and skilfully applied example extant of direct-current driving, but that even with its excellent profile it comes very far short of satisfying reasonable aspirations as regards efficiency is clear—that the brakes and the starting resistances should each absorb half as much energy as is usefully spent on driving the train show the weak points of the system as applied at present.

Energy Account.

	Central London.		Liverpool Overhead.
	Units.	Per cent.	Per cent.
Useful work in driving train . . .	4.0	46	21
Loss in braking . .	2.0	23	50
Loss in motors . .	0.7	8	11
Loss in starting resistances . . .	2.0	23	18
Total units per train-mile . . .	8.7	100	100
Units per ton-mile .	0.064		0.13

As compared with the Liverpool results the Central London Railway results seem good, but in view of all the conditions—of grades, speeds, acceleration, and length of runs—favourable to the latter line, the wonder is that they are not better.

(To be concluded.)

Electric Traction on the Fayet-Chamonix Line.

By J. GARCIN.

THE form of train control recently installed by the P.L.M. Railway Co. of France embodies some interesting features. There are on this line two sharp inclines of 1 in 11 and 1 in 18 respectively, the former extending over 2.155 and the latter 1.386 m. of track. Here, as in the case of all mountain railways, the application of the multiple-unit system ensures special advantages, of which not the least conspicuous is a better adhesion-factor due to a more even distribution of power. The trains are made up of motor-coaches which are all pneumatically controlled from the driver's cab placed in the front. The controlling apparatus being pneumatic does not call for special mention here, but the line itself is well worth a description. The current generated in two separate power houses is taken to the line at a pressure of 550 volts by a third-rail conductor consisting of rails weighing 34.2 kg. per metre, placed on logs of paraffined beechwood, which are fixed to oak sump-planks

lying directly on the sleepers. The top of the conductor is 230 mm. above the line, and its axis is distant 1.083 m. from the latter. Consecutive rails are jointed by fish-plates secured by bolts and washers, and are jointed by naked cable of very high conducting silicon bronze, 175 mm. in section, there being two bonds per joint; the ends of each cable are soldered to cast-iron plates bolted to the fish-plates, and to increase still further the conductivity of the whole, the surfaces of the plates and the rails in contact are coated, after scouring, with a special compound containing tin and mercury. The track-rails are connected in like manner, but with only one bond per joint.

The rolling-stock comprises the following units: Sixteen luggage cars, 8 first-class carriages, 12 second-class, 16 first- and second-, 14 second-class trailers, 31 goods waggons.

Each vehicle has a body of appropriate form fixed to an iron frame which is itself suspended by springs on a motor-truck. The latter is mounted on two axles, each of which is driven by a 4-pole series motor capable of supplying 65 h.p. during two consecutive hours at 550 volts and 275 r.p.m., with a temperature rise not exceeding 60 degrees C. Motors of this type can take a current of 200 amperes without dangerous overheating for at least ten minutes, even when preliminarily heated to a temperature of 40 degrees. The narrow gauge and relatively high power of these motors has led to arranging them perpendicularly to the axles, the drive being taken through spring couplings and bevel gearing of ¼ ratio. The field is of cast steel, forming a waterproof casing in two parts bolted horizontally and completely enclosing the field coils, commutator, and brushes. The lower part which receives the bearings of the armature has two projecting arms pivoting on the axle, which is fitted with interior journals for this purpose. The bevel gearing is of steel and the teeth are very accurately cut; to diminish the wear still further wheel and pinion revolve in a casing whose lower half contains a special lubricating compound. The two truck motors are invariably connected in parallel, and can be disconnected, in case of injury to one, by switch-fuses located in a special junction box. The motors are attached to the frame by plate-springs. The four current-collecting brushes are placed at each end of the truck-frames to which they are connected by spring attachments allowing suitable pressure to be applied on the rails.

Each car is fitted with a four-block brake of the usual type and an auxiliary brake which acts by pressure on the vertical face of the head of a supplementary rail placed in the axis of the line at all points where the gradient exceeds 1 in 12. Both brakes can be operated either directly by the driver, or by compressed air after the manner of the Westinghouse brake. When travelling downhill the block brake is used alone, the other being in reserve in case of accident, or when a prolonged stoppage is necessary. There is a separate magnetic blow-out controlling apparatus in every vehicle for all the driving operations, starting, speed reversing, and regulating and stopping. The speed is reversed by changing the direction of current through the armature, while starting is obtained by successively cutting out the resistances in circuit and speed regulation by shunting the field magnets. When cars are driven singly (*e.g.*, shunting operations in a station) the driver uses the controller handle, but when the cars are coupled in trains of three or four, as is usually the case, a pneumatic apparatus placed under each car is used, which has two air-conduits similar to those in use for the air-brake, the first conduit being used for moving in a forward, and the other in a backward direction. The pneumatic master controller is in the hands of the driver.

The installation has given complete satisfaction in every respect, and as regards the endurance of the motors, practice has shown that they can bear considerable overloads without inconvenience. Thus, in dry weather a single car loaded to ten tons was driven over the 1 in 10 gradient (2,155 metres long) with only one motor in action. Sudden stoppages can be realised by reversing current without fear of injury to the commutator, and this method of braking presents special advantages. The adhesion-factor is very great chiefly owing to the regularity of the driving torque. The importance of careful rail-bonding cannot be overestimated on a line of this description, where a driving current of 900 amperes per train is required in usual conditions. The method alluded to above of coating the surfaces in contact at the joints with a special preparation has given very satisfactory results, thus the mean resistance of one bond was found to vary between .000065 and .000088 ohms; the resistance of the rails themselves was found equal to .000049 ohm per metre, being much greater than if pure iron was used.

The current leakages amount to less than one ampere per kilometre; further the curious fact was noticed that far from increasing in rainy weather or during snowfalls, they diminish slightly. This, according to some opinions, would be ascribed to the fact that the line is situated in a well-protected highly mountainous region, on the border of glaciers forming

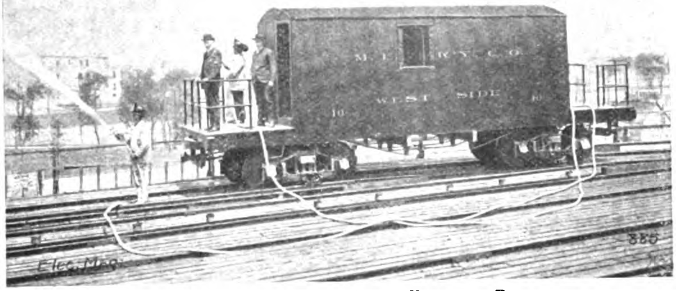


FIG. 1. FIRE-FIGHTER IN USE ON ELEVATED RAILWAY.

the gigantic "massif," of Mont Blanc, where the atmosphere is free from contamination and the water wetting the insulating supports chemically pure, containing no trace of ammoniacal or acid matter, and being therefore a very good insulator.

ELECTRIC ELEVATED RAILWAY FIRE-FIGHTING EQUIPMENT.

A VERY ingenious fire-fighting car has been provided by the Metropolitan West Side Elevated Railway of Chicago, as noted in the accompanying illustrations, Figs. 1 and 2, the latter view showing the apparatus installed on the interior of the car. This outfit includes a chemical fire extinguishing outfit in a fireproof car body. The car is 8 ft. wide and 30 ft. long, that portion enclosing the fire-fighting apparatus being 20 ft. long inside and 7½ ft. wide, with windows and doors as indicated in the illustrations. The enclosed portion is covered with corrugated iron, the platform at each end being of steel plates ¼ in. thick. The car is equipped with two horizontal pressure tanks mounted side by side on the floor of the car occupying a space 4½ ft. wide and 6 ft. long. The upright water supply tank is 3½ ft. in diameter and holds 250 gallons. It is mounted high enough above the floor so that the water will flow by gravity into the pressure tanks, and the soda and other chemicals are stored in a chamber under this tank. The hose provided is 150 ft. long in each hose basket, making a total of 300 ft. of hose line connected with controlling valve and gauge registering to 250 lbs. pressure. The Metropolitan Railway has a number of these cars for use in an emergency in case of fire to an elevated railway train or station. The recharging of a tank requires but four minutes, and one tank will operate for seven minutes at 150 lbs. pressure with both lines of hose working at full capacity. The charges of soda are held in cans of 50 lbs. capacity and one of these is emptied into the cap hole in recharging. This unique and novel car equipment for fire protection in the yards, as well as at the terminals, is said to be most convenient and serviceable.

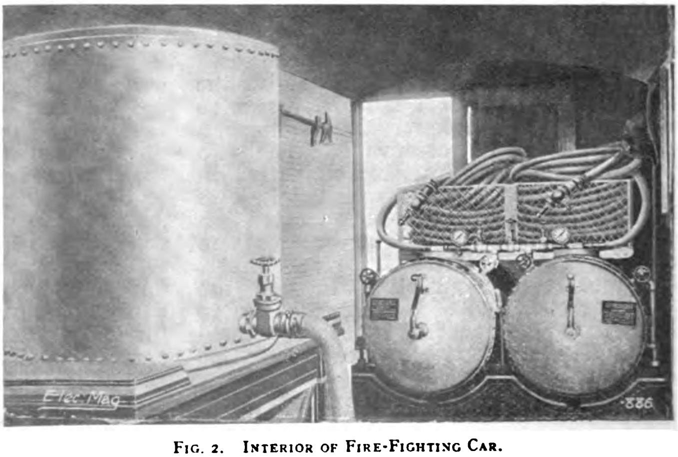


FIG. 2. INTERIOR OF FIRE-FIGHTING CAR.

ELECTRIC MAIL VANS IN MILAN.

A NEW type of vehicle has recently been put in service by the postal authorities of Milan. The van is intended for urban work only, and is fitted up internally like an ordinary post office, containing all the arrangements necessary for sorting, stamping the letters, &c., as well as special apparatus for heating and ventilating, and absorbing vibration. The daily run is about 16 miles. The bags are collected from all the post offices in the city and the letters are sorted out during the journey from one office to the other, and distributed into a number of boxes which are emptied at the end of each run by an equal number of postmen. In this way a letter reaches its destination within two hours from the date of posting. The vehicle weighs 1¼ tons

ELECTRIC MAIL VAN AS USED AT MILAN.

completely equipped, and has two motors which provide a speed of about 16 miles an hour. The driver stands on a platform in the front just as in the case of a tramcar. The system is giving satisfaction, and the constructors, Messrs. Camona, Giussani, Eurinelli and Company, have submitted a scheme for applying it more extensively.

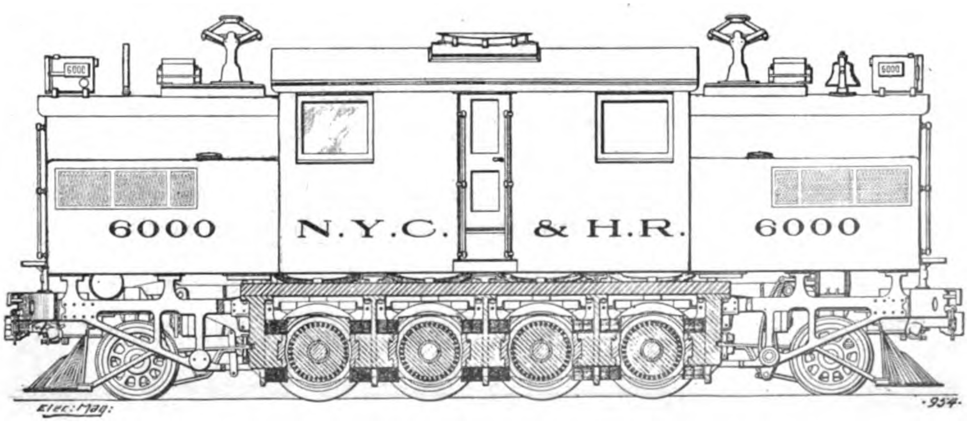
NEW YORK CENTRAL LOCOMOTIVES.

THESE locomotives, to the design of which we referred in the July issue, are now about to be put on the road, the first tests having been recently made. The adjoining cut shows a section through the motor truck exposing the motors and field system. The armatures are built up directly on the driving axles which are so slung that upward movement is possible, the field being bi-polar with horizontal magnets. It will be seen that the magnetic lines pass through the motor armatures in series, the circuit being completed through the frame, but there are also parallel paths through the supports of the intermediate poles. The entire weight is 95 tons, and each motor develops 550 h.p. or a total capacity of 2,200 h.p. The heaviest trains to be hauled weigh 875 tons, but a single loco. will pull a 450-ton train at sixty to sixty-five miles per hour. For the heavy trains two or more locos. will be coupled together and operated on the multiple unit system. The tests were very satisfactory, the acceleration being thirty miles per hour, reached in thirty seconds with an eight-car train weighing with loco. 431 tons, or one-half mile per hour per second. A tractive effort of 27,000 pounds at the rim of the loco. drivers is called for. With a four-car train thirty miles per hour was reached in 37½ seconds, for a tractive effort of 22,000 pounds. Compared with the steam locos. now in use on the New York Central, which have a weight of twelve pounds per pound effective drawbar pull, the electric locos. only have a weight of six pounds. In other words, each electric unit has 25 per cent. greater weight available for tractive purposes than the largest steam passenger loco. now in use with 37 per cent. less dead weight on each axle. In subsequent runs as much as 2,140 kw. was supplied to the loco., the current being 3,400 amperes.

TRACTION NOTES.

Running Powers on Tramways.

MR. STEPHEN SELLON made this the subject of a recent paper before the Tramways and Light Railways Association. He cited instances where running powers had been arranged with advantage, and was emphatic in his support of mutual agreements being come to between tramway concerns, for the good of the public.



SECTION THROUGH ELECTRIC LOCOMOTIVE FOR NEW YORK CENTRAL.

The case of Paisley and the Glasgow Corporation might be taken as having settled the matter of pecuniary return to the owning company; the latter being entitled to a sum in excess of the proportionate mileage for the through fare, and, in addition, the running authority to pay the cost of terminal service and facilities. Running powers alone settled the matter of intercommunication satisfactorily, the through ticket with changes at boundaries being no conciliation. Again the car should be conducted throughout the section by the running authority without change of service men, the whole risk regarding the cars being then taken by the owners, and not by the lessees of the track.

Interborough Rapid Transit Cars.

Two hundred new cars have recently been constructed for the Interborough Rapid Transit Co., New York, by the St. Louis Car Co. The bodies taper toward the top, the height from the bottom of the sill to the top of the roof being 8 ft. 9 ins. The total length of the cars over all is 51 ft. 2 ins., while the length over corner posts is 42 ft. 7 ins. The bottom framing is of wood and steel combined, the bolsters being of heavy rolled steel plates, the top and bottom members being machined at the outer ends, bolted together and reinforced with steel castings which are planed on faces and edges. The cars have a triple floor, the lower floor being covered with ¼-in. asbestos rolled fire felt, and the finishing or third floor is grooved and serves as a floor mat. The car body proper is covered with copper sheathing to make the cars as fire-proof as possible, consistent with building a handsome passenger coach. The interior finish is all of African mahogany, the seats are arranged crosswise in the centre of the car and longitudinally at the ends. The cars are equipped with automatic air brakes and other modern appliances, and are heated with electricity.

Safety Devices for Electric Tramways.

The relation between the safety of modern electric tramways and the patronage they are awarded by the travelling public might be theoretically found to be a direct ratio, but, as the latter continues irrespective of the former, the relative influence of safety devices on traffic may be considered slight. This is, of course, due to the comparatively few accidents occurring on tramway systems. It will readily be understood that safety devices are none the less necessary; and, moreover, considerable care is needed in their selection. In the *Light Railway and Tramway Journal* (November), Mr. T. W. Sheffield commences an excellent article on the subject of tramway safety devices, the first instalment dealing with the question of brakes. Some valuable curves are given showing different effects of braking with track and wheel brakes, and a description is included of the brakes now in common use.

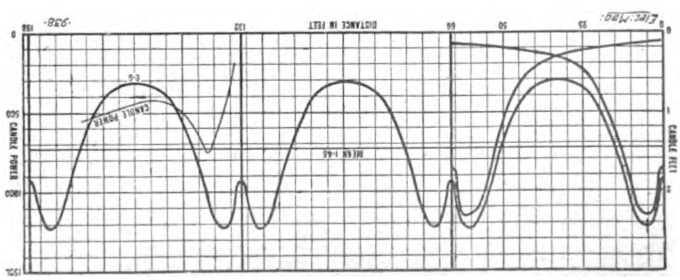
The article is concluded in the December issue and deals with sanding apparatus, lifeguards, signals, and trolley-head devices. A schedule of questions regarding the opinions of tramway managers in this country, on brakes, lifeguards, fatalities, and reversed stairway cars, completes the article. This list contains some very valuable statistics on these points, and the information may well be filed for reference until the adoption of regenerative control or other improvements makes it of no further value.

Readers are referred to the World's Electrical Literature Section at end of Magazine for titles of all important articles of the month relating to Lighting and Heating.

Street Lighting in Manchester.

By the ASSOCIATE EDITOR.

THERE has been lately something in the nature of a competition on a large scale between gas and electricity in the City of Manchester, and the chief electrical engineer to the Corporation, Mr. S. L. Pearce, has just presented his report, dealing with the work of street lighting, in so far as his department has been concerned in the execution of the same. Incidentally, too, he has stepped outside his own department and taken careful note of what has been done by his rivals; the result of these observations has been included in his report. Armed with a portable street photometer, he has gone round the streets, and taken observations on the lamps in the main streets, including arc lamps, intensified gas system, and the ordinary incandescent gas lamps of the Welsbach type. His report is embellished with curves showing the lighting effects of these various illuminants. We are unable to find space for the reproduction of all these curves, but we print one of them as a specimen of the careful work which has been done by Mr. Pearce, and as showing the interest which attaches to the report. The curve, which we reproduce, shows the illumination along the tramway line, where six ampere Gilbert lamps are supported on the poles, sixty-six feet apart. The Gilbert lamps have lately been introduced to replace older forms of arc lamp, which have outlived their day of usefulness, and appear to give great satisfaction. In all there are forty-five of these lamps, and they are said to give a clear and steady light for at least 120 hours without recarboning, trimming, or any attention. The charge for the current supplied for street lighting has hitherto been 2*d.* per unit, but it is now proposed to reduce this to 1¼*d.* per unit, which latter price, according to Mr. Pearce's calculations, will still allow a considerable profit, amounting to 0.3*d.* per unit. Comparing gas and electricity from the point of view of prime cost, it would seem that gas, as represented by the intensified gas system, is 50 per cent. dearer than the arc light, supposing the illumination to be the same in both cases. One can scarcely credit the assertion (which is true nevertheless) that there exist in Manchester twenty-two miles of arc-lighting cable, which cost £13,000, and have never been used. This money has, therefore, been spent without any useful purpose; it has certainly never yet contributed towards producing a single penny of revenue. It is to be hoped that this state of affairs will not be allowed to continue, and that at last an extension of the street lighting on the electrical system and on an adequate scale will be undertaken. The opposition from the gas interest is,



however. more than usually strong, and that is saying a good deal ; and no electrical work is likely to be done without an arduous struggle. However, in view of the facts contained in Mr. Pearce's report, it is to be hoped that the Corporation will not allow their progress to be obstructed any longer.

An amusing sequel to Mr. Pearce's report is noticed by the *Electrician*. It appears that the *Journal of Gas Lighting* thought they might make capital out of the report. and stated among other things that it was well known that the type of photometer which had been employed does not give accurate results. The retort is sufficiently obvious to such criticism as this. Even supposing the results not to be sufficiently accurate for scientific purposes they are yet sufficiently so for the purpose of comparing one light with another ; any errors which arise cancel out. Besides other irrelevant criticism, our gas friends fall foul of the price which it is proposed to charge for current ; and even supposing the maximum demand system to be wrong in principle, it would seem that the critic ought, at any rate, to be aware of the fact that it is very widely used for electrical charges in this country, that most electrical engineers are convinced of the justice and expediency of charges made on that basis, and that ignorance of the first principles of electrical finance seems a poor qualification for a weighty judgment. Naturally enough, Mr. Pearce is able in detail to show the reasonableness of his proposals, and as for the accuracy of his photometric results, it may be said that they very closely agree with those which Mr. Bradley, the surveyor for Westminster, obtained under similar conditions. Our gas friends indeed start by asserting that our figures are wrong, and then politely invite us not to commit suicide by undertaking work at unremunerative prices. But this is of the very nature of competition. Probably everybody who loses a contract comforts himself by assuring his friends that the man who has got the work will lose money over it ; but we all know what that means, having heard in our youthful days of the story of the fox and the grapes. So that if the above-mentioned controversy does no other good, it ought at least to convince the gas fraternity that the electrical department of the Manchester Corporation does not wish to undertake street lighting for the benefit of their health, but rather for the sake of making a modest profit on it.

The Back e.m.f. of the Arc.

The existence of a back e.m.f. of about forty volts in the arc is a traditional dogma which has been instilled into the mind of everybody who holds sound views on the subject. Unfortunately it now seems that it is all a mistake, and that the whole thing will shortly be consigned, as is hoped, to the limbo of the forgotten. Mr. Duddell, whose name is already familiar to all who work with oscillographs, has lately continued his work on the arc, and though for our purposes it will be unnecessary to go at length into his experiments, he finds that the back e.m.f. is about twelve volts with solid carbons, and seventeen volts with cored carbons. The figures depend very much on the make of carbon employed ; with steady arcs, carrying ten amperes between electrodes eleven mm. in diameter, he found that with various makes the back e.m.f varied between about eight and twelve volts, and rose to about fifteen volts if the carbons were previously soaked in a solution of potassium carbonate and then dried. In any case it is quite certain that impurities in the carbons have a very large influence on the arc and its nature. The conductivity of the vapour column itself is probably almost entirely dependent on the impurities present, and if absolutely pure carbons were possible, its vapour, like pure water, would probably have a very high specific resistance. Mr. Duddell's view is that the back e.m.f. is probably a thermo-electric effect, and is caused at the junction of the carbon with the vapour column. He finds, in fact, that there are two e.m.f.'s in the arc, and both occur at the points of contact of the carbons with the vapour column. The one near the positive electrode is the greater and opposes the flow of current, and the smaller is near the negative electrode, helping the current. The main objection to this view is the great difference of thermo-electric power the components of the junction must have ; assuming the difference of temperature to be 1,000° C., the thermo-electric power would be about fifteen o twenty times that between bismuth and selenium. The resistance of the arc may be looked upon as being made up of several components. Firstly, there is the resistance of the vapour column, which depends almost entirely on the traces of impurities present ; secondly, there is the high resistance at the points of contact of the carbons with the vapour column, and at these points of contact very high temperatures are accordingly generated ; and thirdly, there is the resistance due to the thermo-electric forces acting at the two electrodes. The back e.m.f. increases when the impurities are present in large amount, though the conductivity of the vapour column increases. These considerations suggest another explanation for the hissing arc, in which the volts are observed to fall, and it is possible that this is caused by the combination of oxygen or hydrogen with the impurity in the vapour column, and not by combination with the carbon, as suggested by Mrs. Ayrton.

German Types of Photometers.

THE accompanying illustrations show several interesting types of German photometers of simple design as constructed at Frankfort-on-the-Maine by the Hartmann and Braun Actien-Gesellschaft. Fig. 1 is a simple incandescent photometer for use on the Joly principle which admits of very accurate reading. It is so arranged that the light emission of the incandescent lamps can be compared and the ratio read off direct without the use of a dark room. The range on both

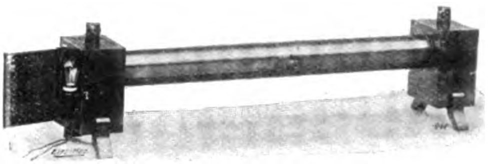
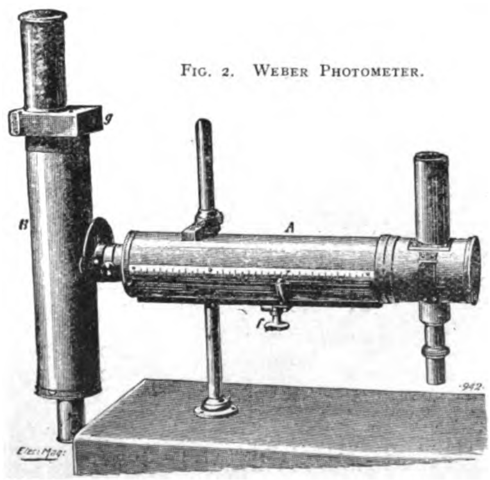


FIG. 1. JOLY PHOTOMETER.

sides is from one to ten poles and standard incandescent lamps are used for direct comparison. The watts taken by the lamp should be read on a wattmeter at the same time. A standard candle or a Hefner lamp can be used for measuring the absolute intensity of lamps within the scale of the apparatus. The Opal glass photometer, in Fig. 2, was designed by L. Weber, and is an extremely portable instrument. It can be most conveniently used to determine the light emission of arc or incandescent lamps at any angle of elevation, and the degree of heat of incandescent lamp filaments, the ratio of the green to the red rays, without extra apparatus. The chief merit of this instrument is said, however, to lie in its ability to

FIG. 2. WEBER PHOTOMETER.



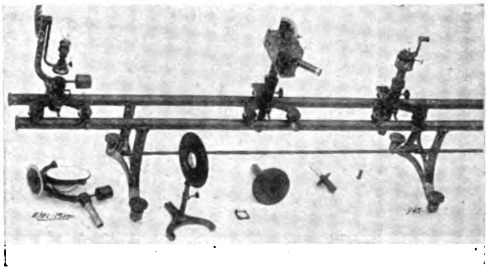


FIG. 3. GERMAN STANDARD PHOTOMETER.

measure the diffused light in a space so illumined in a simple and easy manner, and for this reason its portability is of special advantage.

The Weber opal glass photometer reads the degree of illumination on any surface within an illuminated space in meter candles direct.

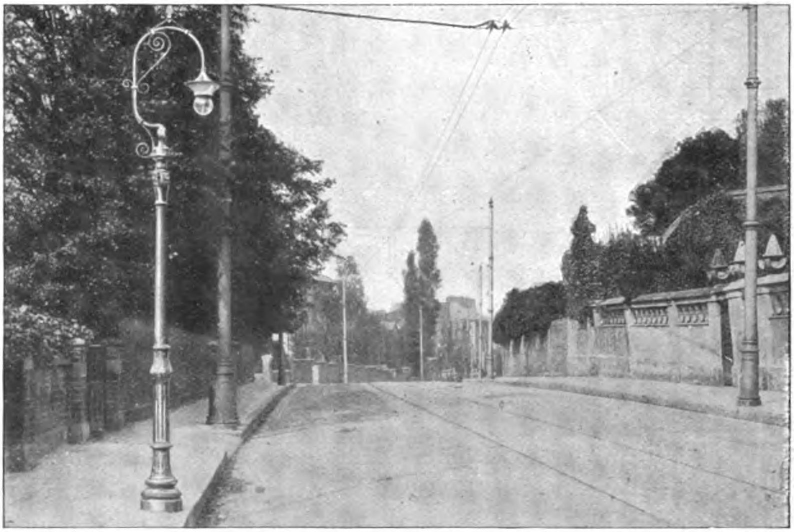
The German Standard Photometer seen in Fig. 3 is fitted with Lummer-Brodhun prisms and has a bench formed of two ebonite coated metal tubes connected together by three vertical frames fitted with levelling screws to form a steady bar.

The front tube is divided into half centimetres with the distance between 100 and 200 graduated in millimetres, the back tube is graduated to read the ratio between the lights under test direct. The three sliding carriages can be clamped at any desired position and are fitted with central tubular supports of which two have rack and pinion motion for height adjustment. The centre carriage bears the reversible photometer screen with the Lummer-Brodhun prisms arranged for the disappearance of one field within the other at equal illumination. Another carriage is fitted with the standard Amyl-Acetate lamp with flame height indicator. The third carriage has various accessories such as a candle holder, incandescent lamp holder, or a plate on which to place a petroleum lamp or other source of light.

F. C. P.

Lighting by Nernst Lamps.

WE have frequently referred in this Section to the value of the Nernst Lamp for lighting purposes and also to the apparent limitations which its present construction impose on its further development. We have had in mind the publication of rather more definite data in regard to these lamps, and the issuance of a special pamphlet in relation to them by the Electrical Co. of Charing Cross Road, prompts us at this juncture to place a few figures before our readers. We need scarcely say that the Nernst Lamp effects a revolution in



NERNST LAMP ON STREET POST.

incandescent lighting. We are convinced that it will be to electric lighting what the incandescent mantle has been to gas lighting. It will stimulate the demand for electricity for lighting purposes both public and domestic, and seeing that marked economies result from its employment, it is natural that this demand should increase. In its present state the lamp is at a disadvantage in that light is not forthcoming for several seconds after closing the switch, and further that the renewals of burners are somewhat more frequent than is the case with the ordinary incandescent lamp. Its disadvantages are, however, of a minor order, and cannot be said to materially affect the wider use of the lamp. That they are generally regarded as of no importance may be gathered from the fact that no less than two and a half million lamps are now in use. Those of our readers who reside in a district having an electricity supply will be familiar with the illumination given by these lamps, so that we need not dwell at length upon this point. In the matter of electric lighting comparative figures are more valuable and appeal more directly to the lay mind than any amount of technical data. For this reason we publish tables furnished by the Electrical Co. comparing the cost of using the Nernst lamp with that of the ordinary lamp. These tables are reproduced below.

Table I.—Comparison of Cost.

One—1 amp. 200 Volt. Luna Nernst Lamp, giving 220 candles.

Two—100 candle-power ordinary Incandescent Lamp, giving 200 candles. In both cases: 1,000 hours, current at 5*d*. per Board of Trade unit

Nernst Lamp.	£	s.	d.	*Ordinary Lamp.*	£	s.	d.
Current: 200 units at 5*d*. per Board of Trade unit	4	3	4	Current: 600 units at 5*d*. per Board of Trade unit	12	10	0
Renewals of burners	0	12	0	Renewals of lamps	0	6	0
	£4	12	4		£13	2	0

Saving £8 9*s*. 8*d*., or 65 per cent.

Table II.

Six—½ amp., B type, 100 Volt Nernst Lamps, giving 102 candles.

Six—32 candle-power ordinary Incandescent Lamps, giving 192 candles. In both cases: 1,000 hours, current at 5*d*. per Board of Trade unit.

Nernst Lamp.	£	s.	d.	*Ordinary Lamp.*	£	s.	d.
Current: 300 units at 5*d*. per Board of Trade unit	6	5	0	Current: 600 units at 5*d*. per Board of Trade unit	12	10	0
Renewals of burners	0	18	0	Renewals of lamps	0	6	0
	£7	3	0		£12	16	0

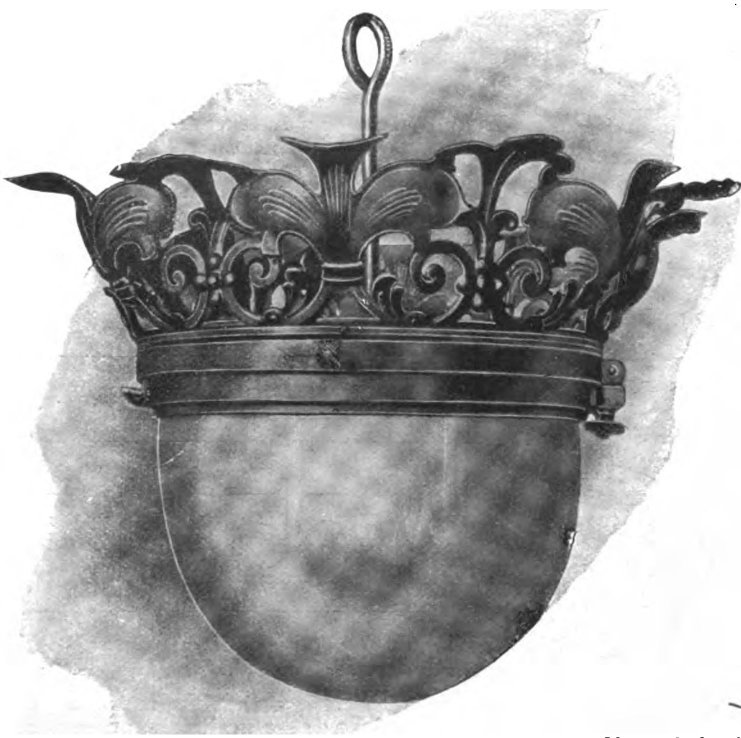
Nett Saving 45 per cent., in spite of 12*s*. increase in renewals!

Seeing that the cost of electricity varies considerably in different districts it will be interesting to show the difference in current consumption with varying prices per Board of Trade unit These prices we give in another table. We also reproduce a few illustrations of Nernst Lamps in use both publicly and privately. It is worthy of note that at the present time the use of Nernst lamps is becoming widely extended, and especially in hotels, clubs, restaurants, and offices. For small towns and suburban districts it is also filling

Cost of Current per year (400 burning hours) for different types and sizes of Nernst Lamps.

	If a Board of Trade Unit costs				
	6*d*.	5*d*.	4*d*.	3*d*.	
A Nernst lamp, 1 amp. 100 volts, giving 110 candles, costs . .	20*s*.	16*s*. 8*d*.	13*s*. 4*d*.	10*s*.	per year
¼ amp. 200 volts, giving 34 candles, costs .	10*s*.	8*s*. 4*d*.	6*s*. 8*d*.	5*s*.	„
1 amp. 200 volts, giving 220 candles, costs .	40*s*.	33*s*. 4*d*.	26*s*. 8*d*.	20*s*.	„
3 amp. multiple lamp, giving 660 candles, costs	120*s*.	100*s*.	80*s*.	60*s*.	„

a long-felt want in the direction of street lighting, but we anticipate that its employment for private purposes will far exceed any other use to which it may be put. Its rays are superior to those of an incandescent gas lamp and more pleasant to work under. Since adopting the lamps in our offices we have been very pleased with the results, as compared with the vacuum glow lamp.



MULTIPLE NERNST LAMP.

THE MOORE SYSTEM OF VACUUM-TUBE LIGHTING.

THIS system has been heard of from time to time in this country; but its practical application was believed to be likely to be postponed for a while. It seems, however, that it has now been used for six months in an installation in America. The first tube was two inches in diameter, and forty three feet long, which means a prodigious feat in glass-blowing. It has, however, been followed by another, of even greater length, in which the illuminating tube is 1¾ in. in diameter, and 154 ft. long. In this last case, the scene of its labours is a business office. Of course it is fed with alternate current at a high voltage. The ends of the tube are brought to a danger-proof steel box, so that all high-tension terminals are properly enclosed. Still supposing the tube should lose its vacuum or get cracked, the work of repair or renewal would seem to be likely to be difficult. Probably if it became cracked, it would be almost as cheap to have a new one, as the labour of sealing in a new length or repairing a crack could scarcely be carried out *in situ*, if the tube were arranged as proposed by Mr. Moore, against the ceiling of the drawing-room. Possibly the comical situations to which the system might give rise strike one too forcibly; but it would almost seem as if the whole of one's house would be filled with glass tubing. Each room would have its own danger-proof box, in which case one could scarcely move without touching them; or, on the other hand, there might be danger-proof boxes at each distributing board, round which would be distributed mazes of glass tubing. We must admit that an economy of 20 per cent. in working expenses hardly reconciles us to the experiment.

Your desk should be illumined by our Special Anniversary and Souvenir Issue.

See that it is.

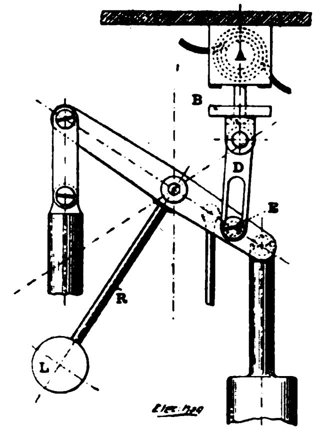


FIG. 1.—CURRENT OFF.

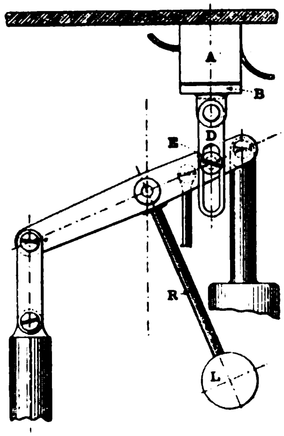


FIG. 2.—CURRENT ON.

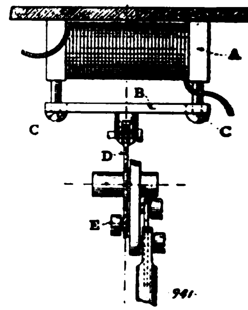


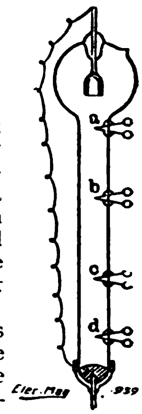
FIG. 3.—END VIEW (OFF).

THE LEWIS ENCLOSED ARC LAMP.

MR. LEWIS'S fertility in design in the field of the arc lamp is well known, and the Reason Manufacturing Company makes good use of the devices which he designs. Mr. Hatfield describes in the *Electrician* some of the latest of these, illustrations of which are shown herewith. They relate to the use of enclosed lamps in series with one another. To the lever, shown in the drawings, is fixed a rod R, which is loaded at the end with a weight L. In this way, the reaction of the mechanism depends on the position of the core, and in each lamp there will be one length of arc which will balance the pull of a given current. The current in all the lamps will gradually decrease till the clutches are released. So long as the current is on, the keeper B is held against the magnet A, and the pin E travels in the slot of link D. As soon as the pin E has reached the top of the slot, the arc breaks and the lever is released. The arrangement here described is particularly suited for the simple construction of midget lamps, which are now better known. It is becoming usual in this country to have only one globe, as opposed to the American practice where two are used. It is very probable that climatic differences may have something to do with this, and the trouble with moths and other insects in the New World has also contributed to the necessity for the employment of two globes.

THE MERCURY ARC.

AS Steinmetz lately pointed out, the mercury arc in a vacuum is the best type of arc in a vacuum generally. Our illustration shows the familiar Cooper-Hewitt tube fitted with exploring thermo-couples, for the purposes of Mr. Wills' experiments. The tube was 1.9 cm. in diameter, and the distance between successive electrodes was 38 cm. The appended table gives figures showing the rates at which the volts fall along the tube, the terminals at a, b, c, and d being connected for the test to electrostatic voltameters. The temperatures in the mercury vapour arc also given.



The next table gives the fall in volts at the anode; these figures are obtained by sealing another thermo-couple into the tube at a distance of half an inch from the anode. It will be noticed that the fall in volts here becomes less as the current increases.

The drop at the cathode is almost independent of the current, and is about five volts. Recklinghausen constructed very short tubes of large diameter, so that the resistance of the vapour should be negligible, and found that the sum of the drops at cathode and anode decreases as the current increases. With 100 amperes, he found that the sum of the two drops was about 7.5 volts.

Current in amperes.	Electromotive intensity in volts per centimetre between			Temperature in degrees centigrade at			
	a—b.	b—c.	c—d.	a.	b.	c.	d.
1.25	0.645	0 660	0.641	123	83	105	134
1 75	0.612	0.612	0.590	143	88	143	160
2.25	0 580	0.585	0.557	172	125	175	200
2.75	0.552	0.559	0.537	200	123(?)	205	241
3.25	0.535	0.548	0.561	243	167	242	297

Current in Amperes . . .	1.25	1.75	2.25	2.75	3·25
Anode drop in volts . . .	6.5	5.8	5.4	5.1	4 6
Temperature in degrees Centigrade	123	143	172	200	243

For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section at end of Magazine.

The Status of the Telegraphist.

By E. O. WALKER, C.I.E., M.I.E.E.

On the progress of affairs during the past fifty years few features are more marked than the part played by the telegraphist. As a rule unostentatious, and reflecting little upon the ultimate consequences of his conscientious work to the issues of the hour, he knows, however, that a small slip, the erasion of a word, or the alteration of a few figures, may be fraught with results of enormous magnitude. It is this ever present sense of responsibility, and the character of his training, which have combined to give the telegraph operator the self-restraint, the calmness in emergency, and the scrupulous exactitude which, in all countries, he exhibits. They have also inspired the acts of heroism which are red-lettered in the annals of the half century we have just left behind.

The histories of the Indian Mutiny, of the war between the Northern and Southern States of America; of the Franco-German conflict, as well as of the recent campaign in South Africa, throw light in a remarkable degree upon the fidelity and fortitude displayed by the telegraphist in positions of difficulty and danger. Such cases are not immediately brought to light, and many are never reported, nor bring to the actor any material rewards, for he is not given to laud his own achievements. It is gratifying to know that such services are not in all instances forgotten. Achievements of forty years ago, and the memories associated with them have been lately recalled in a Bill brought before Congress last session whose object was to provide pensions for the telegraphists who took part in the military operations during the Civil War. We read in the *Telegraph Age* of New York, that Senator Scott of West Virginia, speaking in favour of the Bill recounted much of the history of the service which enabled the armies to keep in communication with each other during that war, and which service enabled President Lincoln to keep in touch with all his generals. The report states that, throughout the war, there were, all told, 15,000 miles of wire operated by this corps of telegraphists, of whom there were 1,200 in the field. At the twenty-fourth annual reunion of the Old Time Telegraphers and of the Society of the United States Military Telegraph Corps at Atalanta, in September last, the Mayor, a former messenger boy himself, touching upon the war period, made plain the fearless spirit which had actuated and controlled those who went to the front. "Never did the man carrying the musket or working the battery," said the Mayor, "show greater bravery or courage than the man who handled the key Often that disciple of Morse was in advance of the troops and liable to capture, or subject to the bullets of his adversaries. But never did I see one falter. Neither did I ever hear of one on the other side trying to keep in the rear."

In the report to Congress, Senator Scott observed that there is the highest satisfaction in knowing that although the telegraphists were acquainted with all the secret orders emanating from the various headquarters and from Washington, telling the movements of troops, not one of them ever betrayed his trust. When the full import of this fact is realised, no greater compliment to the faithfulness of the

operators in trying times and under great responsibilities could be rendered. At New Orleans the telegraphists and linemen were not only in danger of being shot, but risked their lives almost daily in the surf, in trying to keep the submarine part of their system in working order. Regarding the hazardous character of their work, and the fact that they were in many instances unprotected and entirely at their own resources, it is not surprising that there were over three hundred casualties and captures in this little corps, and it is felt that the devotion and bravery exhibited give a claim to comradeship with the combatant troops, and to equal consideration by the Government with the veterans of the war.

If at such times as we have just had under consideration there are opportunities in a conspicuous sense of remarking the behaviour of the telegraphist in the face of danger, there are also circumstances in his civil life, on the railway, in the cable hut, and in the lonely jungle, as well as in the great cities of the world, when the qualities of nerve and of judgment are equally called for, and are not found wanting. A memorial not long ago was raised at Delhi to the noble men who, at the time of the Sepoy rebellion, did their duty to the last; in the solitary forest far away to the north-east of India stands a monument which silently testifies to the devotion of the small party of telegraphists who were shot down when carrying the wire to Manipur during the insurrection there, and tombstones mark the track of the wonderful line stretching across the arid sands of Australia. No less courage in the performance of duty has been shown on the railway road, and in the pointsman's hut, as was recently evidenced when at the risk of his life the telegraphist crossed bridges that were being carried away by floods, in order to signal a train loaded with human freight, to avert an awful disaster.

Lately a number of prominent men in the States were invited to give their opinions as to the qualifications of the men, the incidents in whose lives we have been describing above. There is a general agreement that patience, sobriety, and diligence combined with a good common school education, form the ground work from which the finished operator can be built up. Subsequently his tuition and practice, to place him in the front rank, should ensure his having a thorough knowledge of rules, an ability to read quickly all copy placed before him, to adjust single and multiplex instruments, to send or receive not less than forty-five messages per hour, either by pencil or typewriter, to carry on work for eight hours, and to control his temper. To rise from the rank of operator to higher technical or administrative appointments he must study in his private time.

The public have not been slow to recognise the merits of the telegraphist, so that the salaries paid by most governments and companies are such as to ensure more comfort that can be secured by many workers in modern communities. It has been recognised that the responsible and skilled nature of their employment deserves better pay than that given for clerical work which is under the immediate scrutiny of a superior. This makes the telegraph service attractive. But there is another element which constitutes a source of contentment and ease of mind. This is the knowledge that the employment is continuous from boyhood to middle age, for whether times be prosperous, or the reverse, whether harvests be bountiful or famine stalks through the land, whether war rage or peace serenely reigns, there is always work for the telegraphist who does his duty conscientiously. Indeed there is no need for him to sit for ever at the key, for he can, if deserving, rise to well-paid technical posts in government service, as well as in that of large companies. Experience in the United States goes to show that the larger number of the higher railway officials have begun life as telegraph operators. Some authorities are of opinion that telegraphy is the branch of railway service which offers the best opportunities, and that the thorough training received in early life is a great assistance when the time comes to be placed in charge of a department. The telegraphist to-day, finally, has become a social force, has, in all countries, an assured position, and has acquired a remarkable kinship with his brethren of the Morse key throughout the world.

*The Duplex Balancing of Telegraph Cables.**

By W. GAYE.

The problem of balancing in its mathematical aspect is treated at considerable length in this series of papers. For the arrangement shown in Fig. 1, where R, R_1, are the respective resistances, and S, S_1, the respective capacities per unit lengths of the cables; s, s_1, the respective capacities of the condensers, and l, l_1 the finite lengths, there are three conditions attaching to a perfect balance, viz.:

$$r\,r_1 = (RS_1/SR_1)^{\frac{1}{2}} \quad . \quad . \quad . \quad (1)$$

* Abstract of articles in *The Electrician*, for September 23 and 30, and October 7 and 14, 1904.

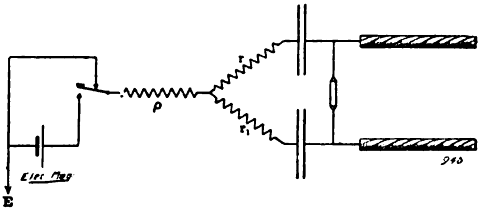


Fig. 1.

which is called for especially at the very outset of affairs and at the intermediate stage to some extent also.

$$s/s_1 = (SR_1/S_1R)^{\frac{1}{2}} \quad . \quad . \quad . \quad (2)$$

required for the somewhat later and intermediate periods. And

$$s/s_1 = Sl\,S_1l_1 \quad . \quad . \quad . \quad . \quad (3)$$

necessitated as the potentials v and v_1 approach their final values. Of these three (1) takes, perhaps, the first rank in importance. The resistance r not only delays and limits the rise of potential, but is responsible for some retardation in its fall also. This is more clearly exhibited in Fig. 2, which illustrates the crests of the potential waves, an arbitrary case in which, owing to r_1 being in excess of what it should be, a balance has not been obtained. Curve 1 represents the potential at the beginning of the upper cable and curve 2 that at that of the lower—or as it would most probably be—artificial line. It is observed that while the values on the cable side are at first higher, they ultimately fall below those on the artificial line side. The current through the receiving instrument arising out of this want of balance is consequently first in one direction and then in the other. As the change in the direction (under ordinary practical conditions) occurs at an enormous speed, the first effect upon the instrument when the want of balance is slight may be small, but is, under any circumstances, extremely rapid, the mechanical result being that of a "jar."

The resistances r and r_1 may be theoretically short-circuited, and the balance remain undisturbed. Of a necessity for their presence in practice there is no doubt. It arises in part from the fact that the various connecting wires themselves possess a small resistance, and, as it would be difficult to ensure that of those on the cable and artificial line sides being otherwise suitably proportioned, it is desirable to furnish some means of compensating for this, which these resistances provide. It is probable also, that they play some part with respect to the balancing of the complex function that we are ignoring, viz., the inductance, not only of the cable but that also of the connecting wires.

Second in importance is the condition (2) which must also be exactly satisfied, although its want of observance creates a difference of potential in one direction only. The close satisfaction of the third condition is of less moment in practice, owing to the fact that a relatively long time elapses after the battery is applied before it becomes prominently called for; the long, slow disturbance or current wave which results from the want of it does not, in signalling also, materially interfere with the more abrupt impulses caused by the signals from the other end. Where this "double-block" system of balancing is employed, the receiving instrument might—for reasons to do with the signals from the other station —be in series with a condenser. The disturbance to the receiving instrument caused by a want of balance is then more complex since it is no longer the outcome of a simple difference of potential, but is caused by the time rate of change in this difference. Under these circumstances, which the demand for an exact fulfilment of the first and second conditions remains, that of the third is of still less practical significance.

It is to be remembered that the current through the instrument is the product of the capacity of the condenser, and the time rate of change in the difference of potentia So that if the latter be small, the instrument may not be sensibly affected, even though the final potential values of the artificial line and cable differ. We may even arrange that one final value may be zero by putting the end on that side to earth, while the other remains finite, without occasioning any disturbance of sufficient amplitude to prohibit signalling or to be even noticeable. These observations hold equally good if, instead of a condenser in series with it, the instrument have in parallel a magnetic shunt, with the difference that the disturb-

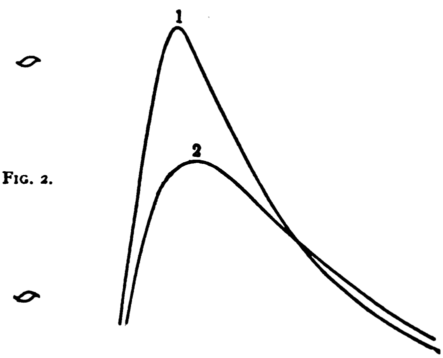


Fig. 2.

ance to the balance becomes again a consequence of the simple difference of potential. By the time that an exact satisfaction of condition (3) begins to be theoretically demanded, the effective resistance of the magnetic shunt will have become almost entirely ohmic, and, as this is usually small relatively to that of the instrument, by far the greater part of any current arising from a want of balance in this respect will pass through it, leaving the instrument unaffected to any serious extent.

In referring to the practical balancing of a cable on the resistance "bridge" plan (referred to in the early part of the paper), it was pointed out that something beyond the simple theoretical conditions given as necessary was required. It was suggested that the need arose from the cable possessing inductance. As will have been anticipated, in balancing on the "double-block" principle, it is also found necessary to either expedite and increase the rise of potential on the artificial line side of the instrument, or to delay and limit it on that of the cable; these objects being attained by inserting resistance on the artificial line side, or by connecting a condenser in parallel with the cable.

While for various reasons the falling short of it may sometimes with the usual receiving instrument be difficult to detect, a perfect balance is not and cannot be produced by the adoption of either the one or the other of these expedients. Their shortcomings are manifested, of course, at the very outset by a disturbance, minute perhaps, but exceedingly abrupt.

It is to be borne in mind that all that has foregone has reference to cables the insulation of which is perfect, and their core ratios unchanged throughout their lengths. A want of homogeneity in this latter respect will affect the potential curve more or less according to, first, its situation in the length, and secondly, its extent. Thus, the substitution of the length of a knot, or even less of a different core ratio at, or near, the beginning of a cable or a corresponding change in the artificial line, will cause the potential on that side to rise either more abruptly or slowly, according to the nature of the difference, and so produce a sudden and marked disturbance of the duplex balance, necessitating an alteration of the conditions for its restoration. If the extent be only that mentioned—viz., a knot or so—as its situation is removed further and further from the beginning, the disturbance of the balance will become less and less marked, soon eventually disappearing so far as to be practically indiscernible. Indeed, in the latter part of cables, or the artificial lines employed in connection with them, very great changes in extent and situation may be made without occasioning any appreciable disturbance of the balance. Where the double-block system is employed —*i.e.*, on long cables—we may, as has been pointed out, even put the end of cable or artificial line to earth, and so make the core ratio there = O, the effect, provided a good balance existed with the end insulated, may not be appreciable, and, in any case, will be but the cause of a sluggish disturbance of small amplitude.

In this connection it may be mentioned that where in consequence of a somewhat insufficient length of artificial line, the potentials at the later stages become on that side too high and are so the cause of a disturbance that, while it is slow, is of inconveniently large amplitude, the defect may be remedied by an arrangement of one or more suitably proportioned "leaks" at, and towards, the end of the line. In cases where a sufficient length of line is more markedly absent, a better plan is to add on some condensers to the end of the line.

When a cable develops a fault, the balance becomes, of course, upset, though, if the fault be steady—*i.e.*, one of unvarying resistance—it may be restored by the insertion of a "leak" of proportional resistance in the corresponding position of the artificial line. Under most circumstances, however, the capriciousness of the fault prohibits this being done. Even then the resulting disturbance is not without its utility, since it affords a rough guide as to the position of the fault. Thus it is at the end nearer the fault that the greatest disturbance is experienced; indeed, at the other end, especially if the cable be a long one, and the fault of high resistance, none at all may be appreciable.

The maintenance of a balance on long cables (where the receiving instrument has a high figure of merit) calls generally for daily and, in some cases, for hourly attention. The cause of this is the variation of temperature, and the factor commonly and most affected by this is the core ratio of the artificial line. It is interesting to note that as a probable consequence of the line's material bulk, there is a considerable time lag in this respect. Thus, a sudden rise or fall in the temperature immediately surrounding the artificial line is not followed by a change in the balance conditions for some hours.

Although it is exceptional, evidence is not wanting that the core ratio of the cable is occasionally affected from the same cause. An instance within the experience of the writer existed in which the daily alteration of the balance conditions did not, during a certain season of the year, follow the variations of temperature surrounding the artificial line. The reason became mani-

fest from the tests of a second short cable running in comparatively shallow water close to, and parallel with, the first for a distance of one hundred miles or so. These indicated at that time of year a change in the total resistance of the cable amounting, at its maximum, to about 3 per cent.

In drawing these notes to a conclusion, expression may be given to the hope that they may be regarded rather in the light of suggestion than as containing any definite assertion. The student should also be warned that in comparing any practically existing duplex balance conditions with those quoted as theoretically necessary, he must not expect to find that they agree. It is suggested that the discrepancy may be accounted for in the neglect in what has foregone of the property of inductance. If this is the case, and it seems reasonable to suppose that it may be, the comparison referred to will afford striking evidence of the potency of this factor at the beginning of a cable. In any case it may encourage an embarkation on a more thorough investigation of the theory of the duplex balance in which, in common with its co-associate resistance and capacity inductance is taken into account.

TELEGRAPH NOTES.

London Fire Calls.

In an account by Mr. J. Sheppard on Fire Calls and Alarms, it is stated that the London Fire Brigade has now 927 public electric alarm points in addition to 264 telephone lines to police-stations, public, and other buildings; from most of the alarm points telephonic communication can be at once established with a police station. Since the fixing of electric call points in the streets of London the proportion of false alarms has increased about 7 per cent. of all calls for fires to about 20 per cent., but notwithstanding this the system is admitted to be indispensable, and of great public utility. Malicious alarms now show a marked decrease, the number of these reported in 1903 being 126.

Galvanometer of High Sensitiveness.

Einthomn has constructed, says the *Bulletin of the Belgian Society of Electricians*, a very sensitive galvanometer, with which it is possible to measure a current as low as 1.70×10^{-10} ampere. The duration of oscillation of the movable system is .003 second and the resistance of the circuit 20,300 ohms. The deflections are read by aid of a microscope giving a magnification of four hundred. The type of galvanometer is that of Depriz-d'Arsonval. The inventor has utilised the quartz fibre of Vernon Bays to constitute the circuit and the spring. The movable part is a flat thread of quartz or two fine threads coupled. The threads are silvered, and form the vehicle of the current. The thread is placed in a very powerful field of 30,000 C.G.S. It constitutes an excellent apparatus for the study of sinusoidal currents and might be doubtless used as an endograph as devised by Blondel. The deviation of oscillation is shorter than the latter and the apparatus would lend itself to photography.

The Telephone as a Receiver for Alternating Telegraph Currents.

The use of a telegraph circuit key and a telephone receiver is embodied in a wireless signalling system for which a patent was granted August 25 to Prof. M. I. Pupin. The disc in front of the permanent magnet of the receiver has a certain definite period of mechanical vibration, so that magnetic impulses received at intervals corresponding to this period will most readily produce a sound in the receiver. The impulses are regulated as to period by arranging the spark-gap in the transmitting circuit so as to allow oscillations to be set up only at the maxima points of the alternating electrical pressure obtained from an alternator. Thus, the oscillations will cause impulses to be propagated from the sending station at each instant when the e.m.f. of the alternator reaches maximum value, and only when the speed of the alternator corresponds to the mechanical vibrating period of the receiver disc will the receiver respond. A telegraph key in the alternator circuits serves the purpose of interrupting the impulses for various lengths of time, so as to render the signals intelligible.

The New Western Union Office at Wheeling, West Virginia.

It was in December 1903, that the Western Union Telegraph Office at Wheeling, West Virginia, was completely gutted by fire. Rising phœnix-like from the ashes, the work of restoring the office, remodelled and equipped with all modern apparatus and facilities of a first-class telegraph office, was completed during the month of August just past. The work was carried out by G. H. Kendrick of Pittsburg, Pa., the district electrician, under the direction of W. N. Fashbaugh of New York, electrician of the Eastern division. Storage batteries have given way to the dynamos, of which eleven have been installed. The old switchboard, which went through the great Chicago fire unscathed, but was destroyed in this later conflagration, has been succeeded by a four-section board, three sections of fifty wires each, with a fourth devoted to burglar-alarm purposes, messenger call, clock circuits, and switches for a quadruple battery. The switchboard is framed in oak and has plate glass panels. In place of the five quadruplexs and six duplexs and two sets of single repeaters in use as formerly, there has been substituted six quadruplexs, twelve duplexs and four sets of Atkinson single repeaters, the latter fitted with direct-repeating Barclay polar relays, the former with radial rheostats. The repeater table, four octette and one sextette tables, are constructed of oak. In other ways the office has been refitted and made attractive.

Telephony.

ACCUMULATORS FOR THE MICROPHONE IN TELEPHONE SERVICE.

THE favourable experience gained in connection with the use of storage batteries in telegraphic service induced the German Telegraph Department to utilise the advantages of accumulator operation also in connection with telephonic service, when no appreciable difficulty was encountered in telephone exchanges. As regards, however, the use of accumulators as microphone current sources in subscribers' stations, special experiments proved necessary, accumulators being discharged there rather slowly, with small currents and at great intervals, which conditions gave rise to self-discharges and sulphating of the plates. In No. 38 of the *Elektrotechnische Zeitschrift* Mr. L. Brückmann records some preliminary experiments made by imitating the conditions of service in a much-used subscribers' station. As no drawbacks were met with at first these experiments were extended in January 1895 to the practical service, thirty-six subscribers' stations being fitted with storage batteries of the Böse system. The following conclusions may be drawn from the behaviour so far shown by these storage batteries: Though the working of the accumulators as far as their resistance to shocks, oxidation of the terminals, &c., was concerned had proved rather satisfactory, the condition of the plates was found to be frequently worse than the electric conditions would have warranted. There is a risk of sulphated cells being put in operation again, such accumulators being subject to complete destruction. Apart from this, however, the charging of microphone accumulators requires much more time and work than that of accumulator cells in normal operation, every cell having to be treated separately. Moreover, different conditions would obtain for different types of cells, so that different kinds of accumulators cannot be connected in a common charging circuit (in series). On the other hand, the initial advantages of accumulator operation for telephone service have lost much of their importance because of the introduction of improved microphones. No further extension of storage battery operation was therefore made by the Telegraph Department.

To Telegraph Students.

Next Year we shall devote space in this Section to a Correspondence Class for Telegraph Students.

Don't miss this Innovation.

Notes on the Baretter and the Electrolytic Detector.

(Concluded from p. 386.)

By L. H. WALTER, M.A., Assoc.M.Inst.C.E., A.M.I.E.E.

IN the first part of this article the different types of electrolytic detectors and the baretter of Fessenden were described, and the properties attributed to each by their respective designers detailed for the purpose of giving a clear insight as to the points at issue. Since then a number of further researches on the subject have been published, including two papers by Dr. de Forest. As these latter to a certain extent are supplementary to the descriptive portion it is proposed to deal with them first before passing to the independent researches and the analytical consideration of the actions which most probably really do take place. The first paper of Dr. de Forest was read before the Franklin Institute; the second, before the International Electrical Congress, was briefly dealt with in the November number of this magazine. The author claims to have discovered the second (or minute electrode) type of cell, and sets out a number of statements as a result of his experiments. Thus, the device is said to be a potential-operated one, since the action only takes place above a certain P.D. (necessary to decompose the electrolyte); (2) it only works with the small electrode as anode; (3) it is a purely electrolytic action and not a heat effect. The last statement was proved by the experiments described, in which an electrolyte having a negative temperature co-efficient was used. Were the effect a bolometric one the effect of the waves would be to decrease the current flowing through the detector cell at temperatures above the critical value. As a matter of fact, however, it was found that the current through the cell was always increased by the action of the waves, even up to the solution's boiling-point. Further, the diminutive electrode was covered with an excessively thin deposit of platinum black, which, as is well known, inhibits the polarising of platinum electrodes, which when bright are readily polarisable. The presence of this microscopic film was sufficient to prevent the cell giving any response to the waves, whereas according to the heat-effect theory, the response should have been practically as good as with the bright electrode. Even very strong waves gave no indication on the detector cell. This is very conclusive evidence that the effect is not a bolometric one. Mr. Smythe, however, in the discussion

on this paper stated as his conviction that the effect was purely thermal.

Coming now to the testimony afforded by the work of independent investigators, it is only fair to state that several years ago Prof. Pupin, in his investigations on the asymmetry of a polarisation cell, pointed out that such cells were capable of rectifying alternating currents even of the frequency of Hertzian oscillations, and, in fact, the statement that he successfully rectified such oscillations is contained in a United States. Patent filed as far back as Jan. 4, 1898.

The first to call attention to the probable inaccuracy of Prof. Fessenden's explanation of the working of the baretter was Dr. Reich, who, some months ago, in the *Physikalische Zeitschrift* described some experiments with a polarised cell, identical with the simple type baretter, using half waves from a condenser discharge for the purpose of determining if the cell were asymmetric. He found that it was asymmetric, and from its general behaviour could only depend on electrolytic action. Later, M. Dieckmann in the same journal, gave confirmatory results from his own experiments. More recently Rothmund and Lessing have published in the *Annalen der Physik* a most complete and instructive research dealing with the electrolytic detector. As the work of these investigators has not yet been dealt with in the English technical Press, it may be well to state the chief points somewhat fully, since, owing to the fact that the experimental figures are given, their results can, at any time, be reproduced, and verified if necessary. These authors did not use the most minute electrodes possible, but platinum wires 0.025 mm. in diameter, fused into glass. But the arrangement corresponds exactly to the baretter of Fessenden. The most remarkable result, which definitely contradicts a number of unsubstantiated explanations which have been offered by experimenters of not quite independent standing, is that the effect is produced when the small electrode is made the kathode, though not quite so strongly as in the inverse case. It is also found that in place of a certain polarising P.D. being necessary (> the decomposition voltage), the effect is produced when such P.D. is below the decomposition voltage, and the relative increase of current through the cell, produced as a result of the action of the waves, is even *greater* for such low values of the P.D. These investigators also made use of an electrolyte having a negative temperature co-efficient (hypophosphorous acid) for the purpose of deciding as to the effect being a bolometric or electrolytic one. Such an electrolyte has been employed by Dr. de Forest for the same purpose, and as there is a thorough agreement in the results obtained, the possibility of a bolometric working is negatived. Using higher polarising voltages, Rothmund and Lessing found that above four volts the effect is only produced when the small electrode is made the anode. This would have seemed to indicate that the effectiveness of the anode is greatly dependent upon the current density were it not for the further statement that the sensibility is very small at such a polarising voltage. This precludes one from supposing that de Forest was working at the same current density as he was explicitly working in the sensitive region. It is further noticed that the potential of the small electrode is invariably lowered by the action of the waves. Finally, an explanation is offered of the action taking place, which, considering the exhaustive nature of the experiments, appears to be deserving of consideration. It is as follows: For such an action a certain minimum current density would naturally be required, and as the currents dealt with in these cells are so very small, it is evident that the area of the electrode must be reduced to an exceedingly small value for this current density to be reached; this is the reason why the small electrode works better the more minute it is. The action of the cell can, in no way, be due to a heat effect, but may be completely explained by considering the effect to be due to a depolarisation. It is, therefore, purely electrolytic in nature.

Having now reviewed the subject from the experimental side, it only remains to examine the evidence at hand and draw therefrom the conclusions—first, those defined by the evidence alone, and secondly those from a general consideration of the entire subject.

As regards the evidence, one fact which seems to be overwhelmingly proved is (1) that the action of the baretter or of the electrolytic detector is not a heat effect, except in so far as every current must generate heat in a medium of less than infinite conductivity, but the amount as compared with the total effect produced is negligible. This is proved by the use of the electrolyte with negative temperature coefficient, by Rothmund and Lessing and by De Forest; and still more decisively if possible by the inhibition of the action by coating the fine electrode with platinum black. Minor confirmation is afforded by the work of Reich and of Dieckmann. The only supporter of Prof. Fessenden in his thermal theory of the working is Mr. Smythe, whose experiments have not been published; these consequently have no weight. (2) As regards the nature of the effect, the results with the coated electrode prove

perhaps more forcibly than any other experimental result could do that the action is really electrolytic, though the fall in potential observed by Rothmund and Lessing is strong presumptive evidence. (3) Whether the small electrode should be made anode or kathode can certainly be answered in favour of the former but the very definite positive evidence of Rothmund and Lessing's experiments shows that it cannot be said, at least for voltages below four volts, that as kathode the small electrode is inoperative. (4) Concerning the applied polarising P.D. necessary there is the greatest disagreement. Dr. de Forest says it must be above the decomposition value and Schloemilch has apparently only tried it so. Decided and even better effects have, on the other hand, been obtained by Rothmund and Lessing below the decomposition value. These dispose of de Forest's statement that the cell is a potential-operated device. From the general point of view it is hoped that the foregoing review and analysis will be of assistance in at least defining those actions which can be accepted as taking place as well as those actions which are excluded from the sphere of possibility. From the point of view of scientific accuracy the numerous and uncalled-for proofs (?) given by Fessenden in his baretter patent specification led one to the conclusion that the working was not so definitely a heat-effect as the inventor wished to convey. On the principle of *qui s'excuse s'accuse*, this was inevitable, and, furthermore, the statements of de Forest, who on his part is interested in the maintenance of the view that the action is electrolytic, led to such a series of contradictory statements that an independent consideration was a practical necessity. In this connection it may be observed that the main facts of de Forest's observations are confirmed. It is only when in working exclusively from the electrolytic point of view that he proceeds to generalise and give explanations not the direct outcome of his experiments that his views may be fairly considered to be unreliable. The question of priority, as before stated, the present article is not concerned with, but it seems part of the very unscientific courtesy, or rather want of courtesy, which appears to be unduly prominent in wireless telegraph research, that no reference is made by all the numerous inventors of these cell detectors to Prof. Pupin's valuable work on the asymmetric cell, although it was probably the latter's results which suggested the use of the electrolytic cell as a wireless telegraph receiver in the first instance.

Wireless Telegraphy and Time Signals.

Chronography.

This system provides for the distribution of time signals by wireless telegraphy. To obviate the expense of transmitting time signals to clocks by the ordinary means, M. Bigourdan has been experimenting with a view to communicating the necessary impulses without wires. A master clock, opening an electric contact each second, actuates a relay which sends a current into the primary of an induction coil, furnished with an oscillator. The oscillation is of very short duration and occurs regularly each second. The secondary is joined to earth and to an antenna of some metres in length, at its respective terminals. Waves are thus transmitted in the usual way. Two different receivers have been tried. The first was a radio-telephone of the Popoff - Ducretet system. The beats were heard very clearly. The second was a recorder as usually arranged except that the Morse was replaced by a chronograph with strip and pin. With the strip running at 1 cm. per second, the signals were good and capable of being regulated to about one-fiftieth of a second. Successful transmission was secured to a distance of 2 km. and little doubt was felt that the whole of Paris might easily be served in this fashion. The author considers that the system proposed by him presents great advantages, not only for the necessities of daily life but especially from a scientific and industrial point of view. It affords means of giving exact time to laboratories, scientific establishments generally, to clockmakers, makers of instruments of precision, &c., as well as for pendulum and longitudinal observations. For ordinary purposes the precision required would be 0.3 to 0.4 second which would be easy to secure, but where great accuracy is required, the signal could be transmitted by the clock used for transit of the stars, the approximate correction being signalled, and the exact correction, after reduction of the astronomical observations, being subsequently communicated.

First Announcement.

Telegraph Students should read the Editorial note in this issue on a new scheme we are introducing for their benefit.

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section at end of Magazine.

Electricity direct from Carbon.

By C. EDGAR ALLEN, A.I.E.E.

THE modern steam-engine, although representing a radical advance upon its predecessors of fifty years ago, is, nevertheless, one of the most wasteful means of utilising the energy of carbonaceous fuel. Of the total amount of energy in coal only about 12 per cent. available for useful work is obtained in the best modern steam practice, and the further conversion of the mechancial energy into electricity by a dynamo means a still further loss. The importance of finding a means of converting a greater proportion of the energy of carbon into useful work than is possible by steam practice has attracted the interest of numerous workers in science and engineering, unfortunately without hitherto obtaining any results capable of application outside the laboratory. Continued attention is still, however, being given to the question, and this, coupled with the fact that it has been theoretically demonstrated that it is possible to obtain electricity direct from carbon, may serve as a justification for hoping that a satisfactory solution will ultimately be found. By the oxidation of zinc in a properly constructed battery of low-internal resistance, the electrical energy obtainable at the terminals may amount to 90 per cent. or more of the energy represented by the chemical process, and the chief direction of investigation has been to find a satisfactory way of utilising a cheaper material than the comparatively expensive metal zinc. Carbon being the most widely distributed energy-source known and, with the exception of water power, the cheapest, it has naturally been looked upon as the substance which should form the consumable element in a cell. Unfortunately, however, there are difficulties in the way of utilising carbon in this manner. The position of this substance in the electrochemical series of metals is a serious drawback. Coming, as it does, between Boron and Antimony it is thus strongly electronegative, which unfortunately limits the materials at disposal for the negative element to the non-metallic series, thus intensifying the already strong electronegative character of carbon. Another drawback is that carbon does not form with an acid electrolyte, a salt, by displacing the positive ion of the electrolyte as does zinc, and further no substance is known with certainty which is capable of dissolving carbon electrolytically. Certainly some experiments made by Coehn have been interpreted as indicating that a voltaic dissolution of carbon can take place, but the difficulty of obtaining pure carbon electrodes has somewhat obscured the real nature of the reaction. When a carbon anode is immersed in H_2SO_4 of a suitable concentration, the carbon goes into solution, the electrolyte becoming red-brown in colour, and by continuing the process, a deep black carbon-like deposit eventually appears at the platinum cathode. This substance, however, is not pure carbon but a mixture of carbon, oxygen, and hydrogen, in all probability a very complex carbo-hydrate. From this it would appear that there is no formation of pure carbon ions. Before proceeding to review the various carbon cells hitherto attempted it may be advisable to ascertain by calculation the possible e.m.f. obtainable from the oxidation of carbon and zinc respectively, in order to make a comparison on that basis. Taking the combination used in the Daniell Cell, 38,066 calories are evolved in the reaction

$$Zn + H_2SO_4 = ZnSO_4$$

and 12,500 calories are evolved by the deposition of copper from its sulphate. Thus the conversion of a gram-equivalent

of Zn or $\frac{65}{2}$ grams, Zn being divalent, and the deposition of a gram-equivalent of copper or $\frac{63}{2}$ grams, copper being also divalent there are evolved altogether 19,033 + 6,250 = 25,283 calories Since by Kelvin's equation

$$E = \frac{H}{Q}$$

where E = *the* e.m.f., H *the heat in calories and* Q *the quantity of electricity* which when the e.m.f. is unity and the temperature co-efficient is zero

$$E = \frac{H}{23{,}000}$$

the e.m.f. in the case of the Daniell Cell is theoretically 1.09 volts which corresponds very closely with the e.m.f. actually obtained. In the oxidation of carbon to carbon di-oxide we have the reaction

$$C + O_2 = CO_2 + 96{,}960 \text{ calories}$$

which, under the condition of the whole of the energy represented by the process being converted into electricity, would give an e.m.f. of 1.05 volt as a maximum obtainable it being remembered that carbon is tetrivalent.

As regards e.m.f., therefore, it will thus be seen that carbon is inferior to Zn, a consideration which is completely outweighed, however, when the relative cost of the two substances is taken into consideration and, when it is remembered that carbon is capable of giving out weight for weight six times as much energy as Zn.

By similar reasoning it has been shown* that by the oxidation of CO to CO_2 at 18°C. an e.m.f. of 1.41 volts is obtained and 0.57 volts for the oxidation of C to CO. A carbon mon-oxide cell would thus appear to have certain advantages in that the CO could be prepared free from the impurities inevitably associated with carbon and which would be likely to set up difficulties in the operation of a carbon cell. Such a cell, as will be seen later, has been attempted by Borchers and Mond. In the reaction

$$C + 2H_2O = CO_2 + 2H_2$$

is found a parallel to that in which Zn displaces the H of H_2SO_4 with the formation of $ZnSO_4$. Lorenz† draws attention to this reaction and to the remarkable result obtained by Bodlaender in his calculations concerning the solution of carbon. These results show that in this reaction 15,230 calories are absorbed which is equivalent to 0.16 volt, in other words, that to bring about a solution of carbon in dilute H_2SO_4 an external e.m.f. of 0.16 volt must be applied. This was actually found to be the case in the experiment made by Coehn, mentioned above, who found it necessary to apply a current to obtain the deposition of the hydro-carbon substances at the platinum cathode. The explanation of this is that it has been found necessary for the reaction to take place, to generate hydrogen, and furthermore to use at the positive pole oxygen or an oxidising agent as a depolariser. An e.m.f. of 1.03 volts with a current of 0.01 amperes is stated to have been obtained by Coehn when using lead peroxide as a depolariser.

The first suggestion for a carbon-consuming cell appears to be that of Jablochkoff, who, under cover of patent No. 493, 1877, produced a combination of the type Fe, KNO_3 carbon, in which coke or other carbonaceous matter was the substance consumed, the electrolyte being a fused alkaline nitrate contained in a cast-iron vessel which constituted the other electrode. The coke was suspended in the pot by means of a basket of iron wire. The reaction that took place in this cell was, that the nitrate parted with its oxygen to the carbon, the resulting current being reputed to have had an e.m.f. of about two volts. This, however, does not appear to have been verified, and must be accepted with caution. In fact it is characteristic of nearly all the carbon cells that the figures given have not been properly verified, and further there is a conspicuous absence of quantitive data as regards the current obtained, consumption of materials, &c.

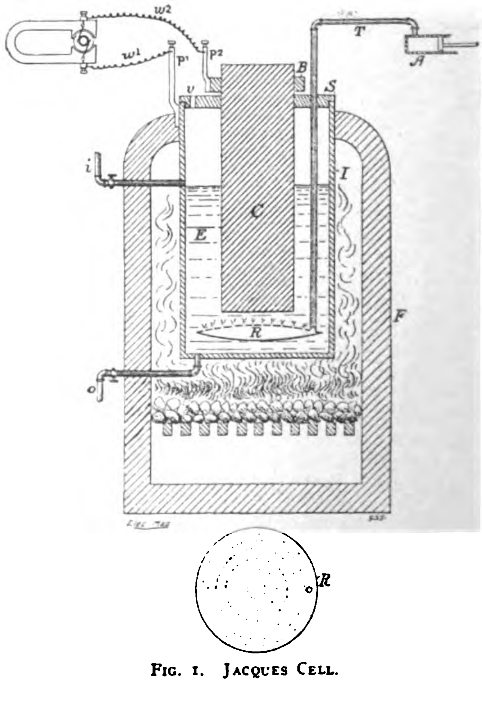


FIG. 1. JACQUES CELL.

* *Elek. Zeit.*, 1895, pp. 502, 507. *Zeit. fur Phys. Chem.*, vol. xxxvi., p. 385.

† *Elec. Chem. Indus.*, January 17, p. 17.

The fault of the Jablochkoff Cell is that the oxidation does not take place voltaically, and continues just the same even if the external circuit is not closed. Another type proposed was Fe, PbO and carbon, which is open to the same objection.

The cell proposed by W. W. Jacques, some years back, seems to have aroused the greatest interest and controversy. It consists fundamentally of carbon, fused sodium hydrate and iron, the arrangement being illustrated in Fig. 1. The electrodes C, are of a form of carbon which is a conductor, and dip into the electrolyte E, consisting of sodium hydrate maintained in a state of fusion (400°–500° C.) by means of a furnace F, surrounding the pot, I, of pure rolled iron forming the non-attackable electrode. A stream of air or oxygen is continuously forced through the electrolyte by the air-pump A, tube T, and rose R. O is an outlet for drawing off the electrolyte when contaminated, and *i*, is an inlet for supplying fresh electrolyte.

In his specification (1896, No. 4,788) the inventor explains the action as consisting in the conversion of the oxygen to CO_2 at the expense of the carbon, the gas bubbling up through the electrolyte and escaping. A portion, however, of the latter combines with the caustic soda to form a carbonate which, together with the ash from the carbon, gradually contaminates the electrolyte and reduces the efficiency. A small percentage of oxide of manganese is said to reduce this action. The e.m.f. of the cell is said to be slightly under one volt, and other figures as given by the inventor pointed to an efficiency of 79 per cent. reckoned on the carbon consumption alone, which, of course, forms no indication of the actual efficiency when the cost of the other materials consumed, the heating of the furnace, and energy consumed by the air-pump are taken into consideration.

The original opinion held by the inventor on the action taking place, was that a voltaic oxidation of the carbon took place at the expense of the oxygen introduced in the electrolyte. This, however, has been disputed by Reed and several continental investigators who hold that the action is in the main, if not entirely, thermo-electric in character, the iron being the hot junction and the carbon, kept at a lower temperature by the injected air, the cold one. Further, that a current passes if an iron electrode is substituted for the carbon one. Even so, it is impossible to say whether the whole of the e.m.f. set up is due to a thermo-electric effect, as electrolytic action undoubtedly goes on which may or may not be of a secondary nature.

Lorenz,* in dealing with the reaction taking place in the Jacques Cell draws attention to the fact that iron by the action of the sodium hydroxide becomes "passive," and further shows that when the carbon is replaced by an iron electrode a current passes from the active to the "passive" iron of the containing vessel. This after a time disappears, owing to the iron point of the electrode becoming also "passive." When the carbon electrode is inserted in the fused mass and connected through a galvanometer with an active iron point, a current flows from the iron point to the carbon in the electrolyte, thus showing that the reaction takes place at the expense of the iron. On allowing the action to continue, the current presently decreases, becomes zero, and reverses in direction, passing from the carbon to the iron at the expense of the carbon.

The latest investigations would appear to show that the advocates of the thermo-electric action of this cell are mistaken in their views. According to Drs. Haber and Bruner,* the "passive" iron represents an oxygen electrode on which the atmospheric oxygen acts similarly, but better, than on a platinum electrode dipped in an aqueous conducting solution.

This action is said to be due to the presence of manganese salts which are always present in small quantities in fused commercial sodium hydroxide and also form part of normal commercial iron. At the carbon electrode the carbon is attacked in the fused sodium hydrate, with the evolution of hydrogen gas, and this it is which determines the potential at the carbon electrode. In fact it would appear that the Jacques Cell is nothing more or less than a hydrogen-oxygen couple, in which the oxygen of the air, by the intermediate action of the manganese salts at the iron electrode, acts with the hydrogen generated by carbon from the fused NaHO at the other electrode. Reed, the principal advocate of the thermo-electric explanation, does not at present coincide with these views.

Theoretically the explanation of the reaction

Fe, NaHO, C,

is of much interest although from a practical standpoint the Jacques Cell is without importance, because of the expense and difficulty of regenerating the materials consumed, viz., the valuable carbon electrode and the costly sodium which is converted into impure soda for the purpose of obtaining a small quantity of electrolytic hydrogen.

The combination Fe, PbO, C referred to above was proposed by Short (No. 22703, 1896), a diagram of the arrangement being given in Fig. 2. A is a suitable vessel containing molten lead at B, and forms the

* *Zeit. f. Elec. Chem.*, vol. ix., p. 159.

* *Cf.* "Proc. Int. Elec. Congress, St. Louis," 1904.

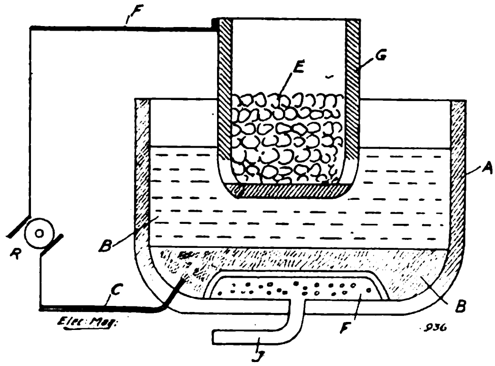


FIG. 2. SHORT'S CELL.

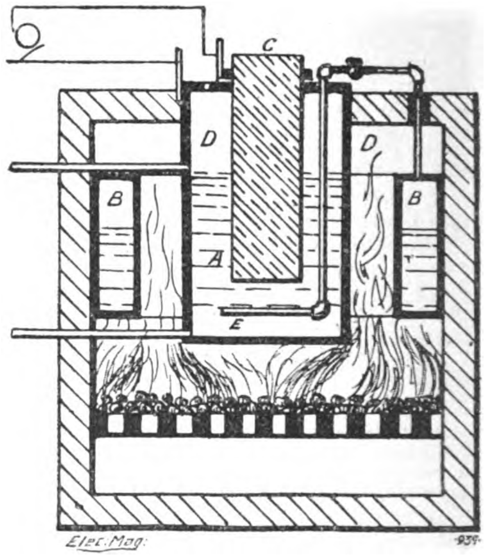


FIG. 3. BLUMENBERG CELL.

negative electrode. The electrolyte consisting of fused lead oxide is introduced in the vessel at B. Partially immersed in the PbO is an iron vessel, G, perforated at the bottom to permit the electrolyte to come into contact with the carbon E. In this arrangement the carbon is oxidised with the formation of CO_2, at the expense of the PbO the metal constituent of which is deposited at the negative plate A. The CO_2 escapes into the air. The oxide is re-formed by introducing air through the tube J. In all probability the e.m.f. is due to a thermo-electric action. The disadvantage of the combination is that the oxidising agent is in direct contact with the positive electrode which is consumed by local action.

Another cell of this type resembling the Jacques Cell in arrangement, is that of Blumenberg, illustrated in Fig. 3. Instead of blowing in air, however, steam generated in the boiler B is introduced into the electrolyte consisting of lime, cryolite, and NaHO. which oxidises the carbon, and is regenerated by the steam which is decomposed. This cell is open to the same objection as those previously described, in that the chemical action takes place whether or not the external circuit is closed because the oxidising agent is in immediate contact with the dissolving electrode. The direct chemical action thus set up is not, as has been pointed out by Ostwald, favourable to the production of electricity, the energy under these circumstances being evolved as heat.

Borchers, in 1894, proposed a process in which oxidisable fuel gases or carbon monoxide were used as anode substance, oxygen or air as cathode substance, and an acid solution of cuprous chloride as an electrolyte. The cell consisted of a copper and a carbon plate, dipped into the electrolyte, one supplied with CO, and the other with air.

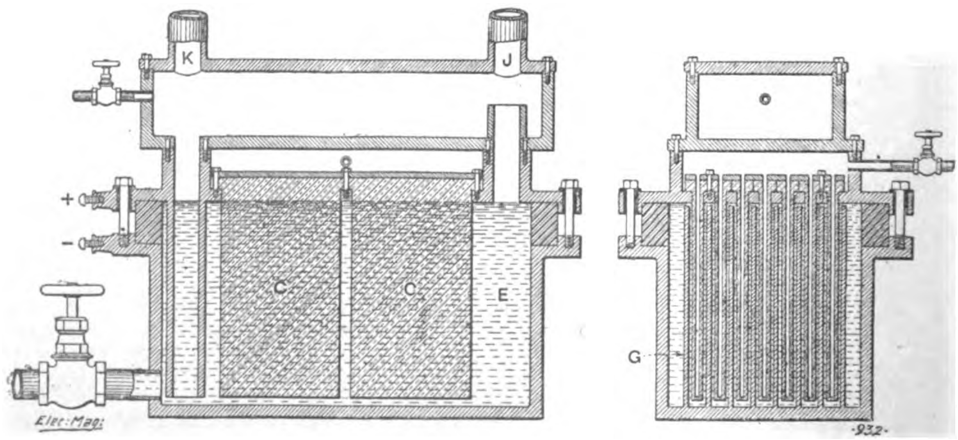


FIG. 4. REID'S GAS CELL.

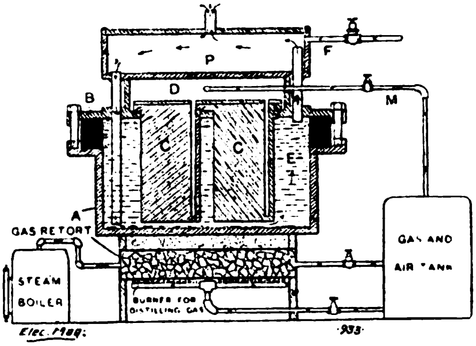


FIG. 5. REID GAS CELL COMMERCIAL ARRANGEMENT.

The feeble current obtained from this cell was assumed to be obtained by the oxidation of the CO to CO_2, but it is now held to be mainly due to dissolution of the copper. Another and more recent example of a battery of the gas type is that of Reed, illustrated in Figs. 4 and 5, and in which a hydro-carbon gas is oxidised. The oxidation takes place in an alkaline electrolyte between carbon and iron electrodes, and sets up an e.m.f. of .9 volts per cell. The gas used may consist of ordinary illuminating gas, containing 650 B.T.U. per cubic ft., diluted with about forty parts of air to one of gas, to maintain an excess of oxygen, for producer or blast furnace gases can be utilised. The gaseous mixture is forced through the electrolyte under a slight pressure, that used at a demonstration of the apparatus given by the inventor being about 4 lbs. per square inch.

The electrolyte has for its chief ingredient caustic soda, to which is added a small quantity of iron oxide, and a little calcium chloride to absorb moisture. The construction of the cell is shown in the illustration. The containing vessel is of iron and is divided into two parts, separated by insulation, and forming the negative and positive poles respectively. From the upper portion are suspended the carbon electrodes CC, which are made in the form of hollow plates having porous walls through which the gas entering the holes in the top may filter and mix with the electrolyte. The lower portion forms a trough containing the electrolyte, and from the base-plate project up the perforated iron plates G shown in the transverse section. Through the hollow carbons the mixture of hydrocarbon gas and air is forced which percolates through the pores of the carbon, out into the electrolyte, passes up through this, and escapes through the pipes KJ. The electrolyte is kept constantly in circulation, and it is claimed that it is not affected by the reactions in the cell as it secures a fresh supply of oxygen in passing through the upper chamber. Most of the oxygen necessary for combination is, however, supplied with the gas. The function of the iron oxide in the electrolyte is, explains the inventor, to serve as an oxygen carrier in a manner analogous to the action of the red-blood corpuscles which carry the oxygen necessary to oxidise the carbon in the lungs. The products of the oxidation and free gases which are combustible, escape through the pipe J. The heating of the electrolyte is accomplished in the commercial apparatus by utilising the heat radiated from the gas retorts, the arrangement being indicated in Fig. 5.

As before stated, the e.m.f. of a single cell is about .9 volt, and this perhaps is the chief practical objection that can be urged against the method, as it would require ten cells in series to obtain 9 volts. The amperage is stated to be proportional to the surface of the carbons, one ampere being generated for every 5 sq. ins. of surface.

(*To be concluded.*)

ELECTRO-METALLURGY.

Classifying Steel.

A RECENT issue of the *Rivue de Métallurgie* contains an interesting attempt to classify steels by an original method. The author, M. Demozay, has observed that different samples of the same kind of steel, when ground on an ordinary grindstone, give off sprays of sparks which always retain the same form and colour; further, the spray assumes different shapes and colours with different varieties of steel or iron, so that these can be readily distinguished from each other by the nature of the sparks they give off. For instance, fibrous iron gives rise to a luminous streak which often does not break or open out, terminating in this case in a small bulb somewhat similar to a grain of wheat, while carbon steels produces sparks whose aspect varies progressively as the percentage of carbon increases, and tungsten steel gives an orange-tinted spray. Annealing, hardening, and other treatments also generally produce characteristic results.

ELECTRO-PHYSICAL NOTES.

Mercury as a Cathodical Basis of Electric Arcs.

THE existence of electric arcs is possible only in case an intensive emission of negative electrons, due to the high temperature, takes place from its cathodical current basis. By an artificial cooling of the cathode, the production of an electric arc is therefore acted against. Now, as the fact that liquid mercury may serve as cathode to an electric arc constitutes an apparent contradiction to this theory, Mr. J. Stark in an article published in No. 23 of the *Physikalische Zeitschrift*, records some observations from which the conclusion is drawn, that in the cathodical basis of a mercury arc, the liquid mercury has the temperature of yellow or white incandescence.

Electrical Conductivity and Percentage of Ozone in the Air.

MESSRS. V. CONRAD and M. Topolansky publish in No. 23 of the *Physikalische Zeitschrift*, the results of an investigation made by themselves into the possible relation between the electric conductivity of air and its percentage in ozone. The dispersion of electricity is found to increase with increasing ozone percentages, so as to establish a connection between the colouration intensity of the iodine paper and the dispersion. As, however, it has not yet been ascertained whether the colouration of iodine paper is really due to ozone itself, further experiments will have to decide if these results imply a connection between the ozonisation of air and conductivity.

Secondary Cathode Rays.

IN No. 13 of *Annalen der Physik*, Professor P. Lenard shows that the passage of cathode rays through the atoms of a body independently of the physical state of the latter, will result in the atoms giving off negative masses.

The issuing speeds, being of a relatively small magnitude, do not as to their direction show any bearing on the direction of the primary rays, nor on the situation of any body surfaces. The amount of issuing radiation may be very great.

The phenomenon seems likely to play an important *rôle* in many cases, where bodies are struck by cathode rays. As, however, it had not so far been observed separately, it should have interfered with many previous researches on the relations between cathode rays and matter.

Photographic Effects due to Hydrogen Peroxide.

AT a recent meeting of the German Physical Society, Professor L. Graetz demonstrated by some interesting experiments the photographical phenomena shown by hydrogen peroxide. A specially remarkable feature is that the effects observed will traverse a series of solid and liquid substances and even metals, so that it would seem as though they constituted a radiation phenomenon. Moreover, photographs of an object may be obtained by their aid, without the same lying between the source of radiation and the photographic plate, a similar behaviour having been observed with no other kind of radiation; this the author calls "back reproduction." Whereas, at first sight it would seem that the effects in question are to be ascribed to the H_2O_2 vapours, this hypothesis is in disagreement with their passage through solid bodies and especially through metals. On the other hand, the effects in question are not made to disappear by blowing away the vapours. Special experiments show other hypotheses, according to which these phenomena would be due to hydrogen, oxygen, ozone or hydroxyl, to be equally admissible.

Professor Graetz states in the photographic plate, differences of colouration which are apparently dependent on the temperature gradient of the surroundings; it is possible thus to recognise differences in temperature only as great as $1/50°$. For the same reason, there is a difference in shading between the middle part and the edges of the images. All these phenomena are possibly due to electrons, though the author does not think it fit yet to decide this question.

Influence of Iron Cores on the Self-Induction of a Coil of Wire.

ANY investigations so far made into the influence of iron cores on coils of wire have been confined nearly exclusively to the magnetism induced in iron, either by direct or periodical currents. Though self-induction has been frequently investigated, this was done merely with a view to finding new methods for determining the co-efficient of self-induction, whereas little has been done in the way of a comparison of the co-efficient of self-induction of a coil of wire with and without iron core respectively. As regards a theoretical treatment of the subject, special difficulties would be encountered because of the many secondary factors (hysteresis and Foucault currents, &c.) to be taken into account, which are susceptible of determination only by way of experiment. The problem has, on the other hand, a practical bearing on the construction of induction coils, so that an experimental investigation was highly to be desired.

Professor Ad. Heydweiller, of the University of Munster, Germany, therefore suggested an experimental research on the relation between the self-induction of a coil inclosing an iron core on the one hand, and the following factors on the other: first, the current intensity, both in the case of a single and a periodical current interruption; second (in the case of periodical currents), the frequency; third, the dimensions and mass of iron cores; and fourth, the distribution of iron masses.

This work was undertaken by Mr. W. Hamacher, on the method suggested by Maxwell, for the determination of constants of self-induction, the results being as follows:

(1) The co-efficient of self-induction increases along with the mass of the iron cores, according to the greater magnetic induction.

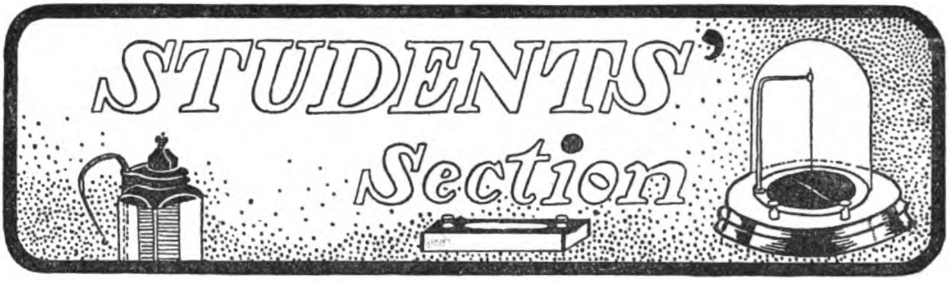
(2) The difference between the co-efficients of the self-induction of different iron cores is greater in the case of periodical currents than with continuous current.

(3) Each core shows a maximum constant of self-induction with a current intensity ranging between 1 and 5 mm. amperes, corresponding to a field intensity of 1.5 to 7.5 c.g.f. units.

(4) The figures found for the constants of self-induction in the case of a periodical alternate current approach closer to the values stated for a massive iron core, while in the case of direct current, the figures found for a bundle of iron sheets are practically the same as those observed with big bundles of iron wires.

(5) The shorter massive iron cores have a greater self-induction; such iron cores are therefore to be preferred in the manufacturing of induction coils.

(6) Great differences of magnitude which are to be ascribed to peripherical induction currents, are stated according to the number of periods especially in massive iron cores.



Students should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles of special interest to them.

Problems on Distributing Networks.—II.

By ALFRED HAY, D.Sc., M.I.E.E.

(Continued from page 510.)

Case of Uniformly Distributed Load.

If the branch currents are all equal, and are tapped off at equal intervals along the main, the problem of finding the drop becomes particularly simple. Let there be n branch currents, each of amount i, and let r be the resistance of any section of the main between two points at which currents branch off. Using the same notation as before, we have $R_1 = r$; $R_2 = 2r$; $R_3 = 3r \ldots$; $R_n = nr$. Hence drop along main $= R_1 i + R_2 i + \ldots + R_n i$

$$= ri(1 + 2 + 3 + \ldots + n)$$
$$= ri\,\frac{n(n+1)}{2}.$$

Now if the number of points to which currents branch off is indefinitely increased (the total current taken off per unit length of cable remaining unaltered) we may write n for $n + 1$, and the expression for the drop becomes

$$ri\,\frac{n^2}{2} \ldots . (3)$$

Since in = total current taken from the main and $\frac{rn}{2}$ = resistance of half the main, we see that *with a uniformly distributed load the drop is the same as that due to a current equal to the total current, tapped off at the middle point of the main.* When the exact distribution of the load is unknown or uncertain, the above rule may be conveniently used. It may also, in order to save time, be used in cases where only an approximate result is required.

The expression for the drop due to a uniformly distributed load further shows that, for a given value of i (or, what is equivalent to this, a given number of amperes per unit length of main), the resistance per unit length of main must vary inversely as the *square* of the length if the drop is to remain constant; for if $ri\frac{n^2}{2}$ is to remain constant, and if i is fixed, it is evident that rn^2 must be constant; but n is proportional to the length of main. Thus, since the resistance per unit length is inversely proportional to the cross-section, we arrive at the following result:

In order that the drop may remain the same for mains of different lengths but uniformly loaded with the same number of amperes per unit of length, the amount of copper in a main must be proportional to the cube of its length.

From this we see that, so long as the simple arrangement shown in Fig. 1 is adhered to, the cost of the copper in the main will increase in simple proportion to the cube of its length—assuming the main to be of constant cross-section throughout its entire length—and a prohibitive cost will soon be reached. It might at first sight be thought that the difficulty due to an excessive drop could easily be overcome by using lamps of different voltages along the various sections of the main, lamps of higher voltage being used in the immediate neighbourhood of the generating station, and lamps of lower voltage at the more distant points. This arrangement would, however, never do; for although the voltages

might be so chosen that during the hours of full load each lamp was getting approximately the right voltage, yet as soon as the lamps began to be switched off the drop along the main would decrease, the P.D. at its far end would rise, and in consequence of this the more distant lamps would be destroyed in a short time.

Feeders and Distributors.

The practical solution of the problem consists in using two totally distinct classes of mains, known as *feeders* and *distributors.* The term *distributor* is almost self-explanatory: it denotes a main which distributes the current to the various houses where it is required. All the mains we have hitherto considered have been distributing mains.

Let us suppose that the arrangement of Fig. 1 has been pushed up to a limit beyond which the cost of copper in the distributing main becomes prohibitive, and let now the generator be shifted from its original position at one end of the main to the middle point of it, as shown in Fig. 6. While maintaining the same drop along each of the two branches FA and FB as along the original main, we

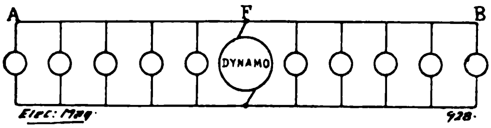


Fig. 6.

can now afford to reduce the cross-section of these to one-quarter of the cross-section of the original main. By merely changing the position of the generator, therefore, we have reduced the cost of the copper in the distributing main to a quarter of its original amount. Suppose next that we are dealing with a length of main whose cost would be excessive even if the generator were placed at its middle point. Then we may subdivide it into two sections, A_1 B_1 and A_2 B_2 (Fig. 7), and instead of using a single large generator, use two smaller ones, connecting them to the middle points F_1 and F_2 of the two sections, as shown in Fig. 7. There are now two small generating stations instead of one large one. The two sections may be connected, as shown by the dotted lines, to form one continuous distributing main. With a still longer main, we may imagine it sub-divided into three sections, each of which is fed by a generator connected to its middle point. Thus the cost of the distributing main may be kept within reasonable bounds by feeding the current into it at a number of points instead of at one end only.

Such a subdivision and scattering of the generating plant would, however, obviously present very serious disadvantages, and

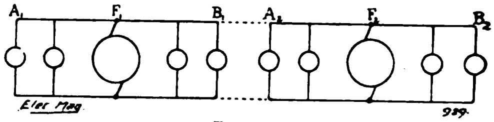


Fig. 7.

we may next arrange to have all our generating plant in one building, while still feeding the current into the distributor at a number of feeding-points (instead of at one end only) and maintaining the various feeding-points at the same difference of potential. In order to do this, we must use a set of conductors connecting the generator or generators to the various feeding-points. Such conductors are termed *feeders.*

In the simple case of Fig. 7, if we suppose that for some particular reason (cheapness of site, or facilities for obtaining coal and water) it is advisable to have the generating station at one end of the line, the arrangement of feeders and distributors would be as shown in Fig. 8. If a single generator supplies both feeders, the drop along each must be the same if the two feeding-points are to be maintained at the same P.D. This equality of drop may be obtained by introducing into the circuit of the shorter feeder a resistance or a counter E.M.F. of suitable amount. Two important points of difference between feeders and distributors must be particularly noted. The current has the same uniform value along the entire length of a feeder, whereas it is variable from one section to another of a distributor. Again, if the position of the feeding-points is given, the size of the distributor is determined solely by the permissible drop; whereas in the case of a feeder we may arrange the drop to be anything we please. The drop along a distributor is limited by the Board of Trade regulations, according to which the P.D. at any point of a distributor should not differ by more than 3 per cent. from the normal P.D.

Law of Economy.

In the early days of electric lighting, the only consideration which governed the choice of the cross-section for a main was the maximum safe rise of temperature. It was only when Lord Kelvin, in 1881, attacked the problem, that electrical engineers became aware of the fact that the smallest

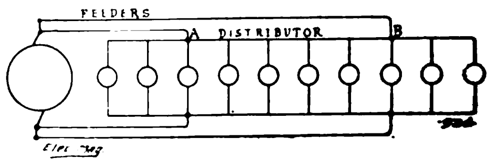


Fig. 8.

cross-section consistent with a safe temperature rise was not necessarily the best cross-section from an economical point of view. The considerations which govern the choice of the best cross-section for a given feeder are frequently referred to as Lord Kelvin's Law of Economy. Any feeder may be regarded as forming a source of annual expenditure in three different ways: (1) A definite amount is required to pay the necessary interest on the capital representing the first cost of the feeder; (2) Owing to the repairs which may be necessary from time to time, and the fact that in course of time the feeder may have to be replaced on account of the gradual deterioration of its insulation, a certain amount must be allowed to cover the cost of repairs and renewals; (3) Since the feeder absorbs energy, and since energy costs money, the total energy dissipated in the form of heat in the feeder will represent a definite sum of money lost each year in the feeder. It is usual to group the first two sources of expenditure together under the head of "interest and depreciation." The amount to be allowed for this is necessarily variable, but may, in most cases, be taken to lie between 8 and 10 per cent. The cost of the energy wasted will depend on the cost of generating a Board of Trade unit (or kilowatt-hour), which again is variable, and depends on local conditions; in most cases, it may be taken to be between $\frac{1}{2}d.$ and $2d.$

It will now be evident that the best size of cross-section is that for which the total annual expenditure is least; that is to say, for which the sum of the amount to be allowed for interest and depreciation, and the cost of the energy wasted in the feeder, is least. This is the law of economy. In order to illustrate the application of this law, we shall work out a numerical example. A feeder is required to convey a current of 200 amperes. Assuming that the allowance for interest and depreciation is 10 per cent., and that the cost of generating a Board of Trade unit is $1d.$, it is required to find the most economical cross-section, the loss of energy in the feeder being equivalent to the passage of the maximum current of 200 amperes during $2\frac{1}{2}$ hours each day. It is evident that since both the amount allowed for interest and depreciation, and the cost of the energy wasted, increase in simple proportion to the length of the feeder, the most economical cross-section will be *independent of the actual length of feeder.* For the sake of convenience, therefore, we may assume a length of one mile. By referring to the price-list of any reliable firm, we can find the price, per mile, of various sizes of cable. By taking 10 per cent. of this, we get the amount to be allowed for interest and depreciation.

A demand lasting $2\frac{1}{2}$ hours each day is equivalent, in the course of a year of 365 days, to a total demand during $365 \times 2.5 = 912.5$ hours. Hence, r being the resistance of one mile of cable, the watt-hours wasted in the course of a year amount to $r \times 200^2 \times 912.5 = 3.65 \times 10^7 r$. The total cost of this energy is, at $1d.$ per Board of Trade unit, equal to $£\frac{3.65 \times 10^4}{240} r = £152\,r.$

We may now construct the following table: *

Size of cable.	Cross-section in sq. ins.	Resistance per mile.	10 % on cost of cable, £	Cost of energy wasted, £	Total annual cost, £
19/18	.034	1.245	10	199	209
19/17	.046	.915	12.5	139	151.5
19/16	.060	.701	16.8	106.5	123.3
19/15	.0765	.553	20.2	84	104.2
19/14	.0944	.448	24.6	68	92.6
19/13	.125	.339	31.0	51.5	82.5
19/12	.159	.265	38.6	40.3	78.9
37/14	.184	.230	42.4	35	77.4
37/13	.243	.174	54.5	26.4	80.9
37/12	.310	.136	69.3	20.7	90
61/12	.512	.0827	112.5	12.6	125.1

The values of the total annual cost may now be plotted against the cross-sections.

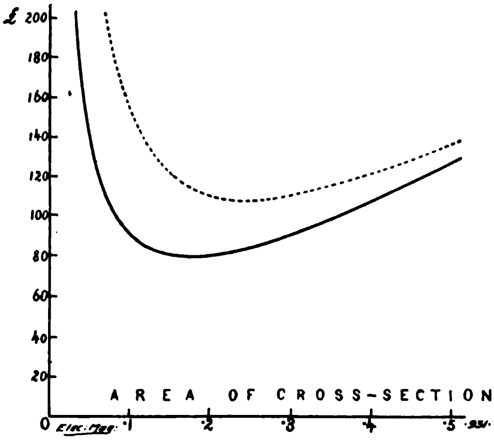


Fig. 9.

as shown by the full line in Fig. 9. We see that the total cost rapidly decreases to a minimum reached at a cross-section of about .184 sq. inch, and then slowly increases as the cross-section is further increased.

In order to show the effect of increased cost of generation, we may recalculate the total annual cost on the basis of, say, $2d.$ per Board of Trade unit. This means doubling the energy cost in the table given

* The feeder is supposed to be a low-tension one, insulated with vulcanised indiarubber.

above. We thus obtain the following table:

Cross-section, in sq. ins.	10 % on cost of cable £	Cost of energy wasted £	Total annual cost £
.034	10	398	408
.046	12.5	278	290.5
.060	16.8	213	229.8
.0765	20 2	168	188.2
.0944	24.6	136	160.6
.125	31.0	103	134
.159	38.6	80.6	119.2
.184	42.4	70	112.4
.243	54.5	52.8	107.3
.310	69.3	41.4	110.7
.512	112.5	25.2	137.7

On plotting these results as before, we obtain the dotted curve shown in Fig. 9, which gives the relation connecting the total annual cost with the cross-section of the feeder. It will be immediately seen that the effect of increased cost of generation has been to shift the minimum point to the right, *i.e.*, to make the most economical cross-section greater than before. This cross-section is now about .25 sq. in.

It will be further noticed that on account of the slowness with which the total cost increases as the cross-section is increased beyond the most economical value, a considerable amount of latitude is permissible in the choice of the cross-section without unduly increasing the total annual cost. This remark, however, only applies to the special case considered, which is that of a low-tension feeder. It will be found that in the case of high-tension feeders, whose insulation is much more expensive, the minimum point in the curve of total annual cost is marked much more sharply, and any departure from the most economical cross-section will involve a relatively large increase in the annual cost.

We have so far regarded the cross-section of the feeder as determined solely by considerations of economy. There are two other considerations, however, which may limit our choice, and which under certain conditions may make it impossible to adhere to the cross-section dictated by economy. These are (1) The maximum permissible rise of temperature; and (2) The maximum permissible drop along the feeder.

Returning to the numerical example just considered, and taking the cost of generation at 1*d.* per unit, we have for the most economical cross-section .184 sq. in., corresponding to a 37/14 cable. According to the standard laid down by the Institution of Electrical Engineers, the maximum current which should be allowed in a cable of this size is only 187 amperes, whereas our maximum current is 200 amperes. By adhering to the most economical cross-section we should, therefore, in this case be working perilously near the limit of safety as regards heating It would, therefore, be advisable to increase the cross-section, using a 37/13 cable (which is capable of taking 235 amperes with safety) the consequent increase in the total annual cost would amount to only $4\frac{1}{2}$ per cent. (as wil be seen by a reference to the table). When, in the special example considered, the cost of generating a unit is 2*d.*, the limit imposed by temperature rise does not interfere with the adoption of the most economical cross-section. But a limit may be imposed by the permissible drop of voltage along the feeder. Let us, for example, suppose that we are dealing with a 240-volt two-wire system of distribution, and that it is desired to keep the drop along the feeder within 20 per cent., *i.e.*, within forty-eight volts. With 200 amperes, this would correspond to a resistance of the double feeder (positive and negative) equal to $\frac{48}{200} = .24$ ohm, so that the resistance of a single length of feeder should not exceed .12 ohm. Referring to the table, we find that with a 37/13 cable this corresponds to a distance of $\frac{.12}{174.} = .69$ mile, or about 1,200 yards. If, therefore, the distance of the feeding-point from the generating station exceeds this limit, the most economical cross-section must be exceeded if the permissible limit of drop is to be complied with.

ALTERNATING CURRENT WORKING.

By W. B. GUMP, from "Western Electrician."

Polyphase Induction Motors.

The characteristic qualities of the polyphase induction motor are high efficiency, compactness for output, and its good starting qualities. The elementary principle upon which the theory of the polyphase induction motor is based is given as follows. Suppose that the inner pole-pieces a, b, c and a', b', c' (Fig. 1) respectively be connected as shown, and that three-phase currents be supplied to the terminals T, T′, and T″. Starting at the terminal T, let the current of the first phase magnetise poles a and a' of opposite polarity. Similarly the current of the second and third phases will magnetise the poles b and b', and c and c' respectively, so that the poles a, b, and c are of the same polarity, and the poles a', b', and c' are of opposite polarity, and it

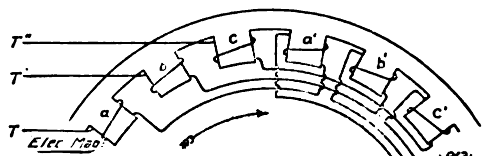


Fig. 1.

will be observed that the polarity of each group will reverse its polarity each half-cycle, and as there are three poles in each group their phase difference will be one-sixth of a period. Now it is evident that if the adjacent poles change regularly from phase to phase, the result will be a rotating magnetic field in the direction of the arrow. If in such a field an armature be placed whose coils are short-circuited, currents will be induced in these coils, and the current will react on the field, causing a "drag" upon the armature which will thereby cause it to rotate. The stationary part of the motor is called the *stator*, and the part which rotates is known as the *rotor*.

If f be the frequency of the electromotive-force supplied at the terminals, P be the number of pairs of poles per phase, and V be the speed in revolutions per minute of the field, then one revolution is made in $\frac{P}{f}$ seconds, and $\frac{f}{P}$ revolutions per second $= \frac{V}{60}$ Therefore,

$$V = \frac{60f}{P}$$

If $V' =$ the speed of the rotor, then the relative speed between any given armature inductor and a fixed point on the stator will be $V - V'$ revolutions per minute. The ratio of this difference to that of the field velocity is called the "*slip*," and

$$S = \frac{V - V'}{V}$$

The slip is generally expressed in per cent. of the synchronous speed. If the flux from a single pole of the stator is ϕ maxwells, the effective e.m.f. in a rotor inductor will be expressed by the equation:

$$E = \frac{2.22\, \phi\, PSV}{60 \times 10^8}$$

where P = number of pairs of poles in the rotor.

The electromotive-force thus induced will not have the same frequency as the impressed electromotive-force of the stator, but will have a frequency S times the frequency of the impressed primary current. This condition is made use of in cases where change of frequency becomes desirable, especially that of changing from a low to a higher frequency. Such an appliance is known as a *frequency-changer*, and operates in the following way: A synchronous motor is direct-connected to the rotor of an inductor motor which is made to rotate in a direction opposite to its rotating field. The stator windings of the induction motor and the terminals of the synchronous motor are connected to the low-frequency mains. Slip-rings in the rotor of the induction motor lead off current at the higher frequency. The power required to drive a frequency-changer is the same percentage of the output as the ratio of the low frequency to the higher frequency.

Suppose that an induction motor is being operated without any load. The rotor will revolve but a trifle slower than the field. This difference in speed will just be sufficient to induce the necessary electromotive-force which will cause the required current in the rotor to make up for the losses due to friction, windage and the copper and iron losses of the rotor. If now a load be put on the motor, its speed will be lowered, and consequently the slip will increase. This will cause an

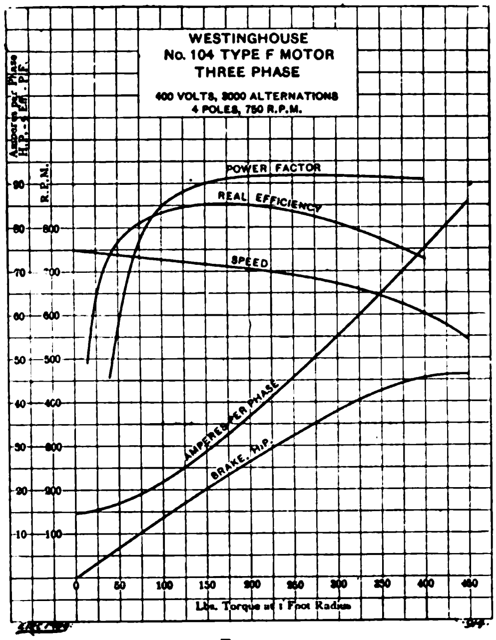


FIG. 2.

increase of electromotive-force and current in the rotor, and an increase in power thereby, which will meet the requirements of the load. In this respect the induction motor operates in a similar manner to the direct-current shunt motor.

If the rotating magnetic field of an induction motor were constant at all loads, the slip, rotor electromotive-force, and current would vary directly as the torque applied. This, however, is not the case for the following reasons: Upon the increase of slip, a greater proportion of flux passes between the stator and rotor windings without interlinking them. The cause of such leakage is due to cross-magnetisation, which increases with the increase of current in the rotor. The decrease in useful flux therefore

lessens the torque for a given value of current and requires a greater amount of slip to produce the same current. The relations between speed, power factor, and efficiency for an induction motor are shown in Fig. 2. Torque depends upon the product of the field flux and the rotor ampere-turns. Therefore the torque varies as the square of the impressed voltage. It follows from this that the power of an induction motor will change if it is operated on a circuit of a different voltage.

The power factor of induction motors is low due to the magnetic leakage between the windings. This leakage is, of course, increased by an increase in the air-gap. It is of the highest importance, therefore, to have the gap as small as possible, and also to have rigid bearings which will maintain perfect alignment. On account of a low-power factor, induction motors should have a lower rated capacity than transformers, from which they are operated. In practice the capacity of the motor in horse-power is made equal to the transformer in kilowatts. It is evident that this rating will provide for

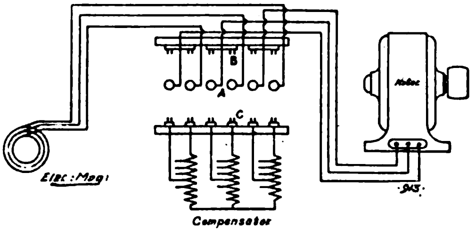


FIG. 3.

an extra supply of current from the transformer to make up for all losess.

Methods of Starting Induction Motors.

In order to prevent excessive rush of current on starting a motor of the squirrel-cage type, it has been found necessary to employ some form of starting compensator. The construction of such a compensator consists essentially of a combination of auto-transformers (one for each phase), which are interposed between the supply mains and the motor terminals. In this way the voltage is reduced on starting; hence the starting current is also reduced.

The form of compensator just described is shown in Fig. 3, and is typical of the starting arrangement for motors of the polyphase type. When the motor is not running, the switch stands at the *off* position on the hinge clips at A. To start the motor the switch is brought upon the contacts at C and held until the motor reaches normal speed. The switch is then quickly raised and placed upon the running side at B, where it is connected to the main circuit. Several taps are shown on the compensator, which makes it adjustable to the peculiar demands of the motor and the voltage employed. When once it is adjusted correctly, it should be made permanent and the connections not disturbed afterwards unless special conditions demand a new adjustment.

Another method of starting is to use a centrifugal friction clutch on the motor, starting it without load. When the motor reaches normal speed the clutch acts automatically, throwing the load upon the pulley. In this way the starting current is practically the same as the working current.

The direction of a three-phase motor may be reversed by reversing the connection of any two of the terminals. A two-phase motor may be reversed by reversing the connections of either phase

Means of Varying the Speed.

The problem of varying the speed of induction motors has been given considerable attention, since there are certain classes of machines which demand changes of speed to accomplish the work to which they are put. It is evident, therefore, that unless some simple means is devised which will alter the speed of an induction motor, its range of usefulness will be limited It becomes necessary also to maintain a moderately high efficiency with variation in speed. The means of speed-variation of induction motors under present conditions resolve themselves into four ways, *i.e* :

(1) Altering the voltage impressed upon the stator.
(2) Altering the rotor-circuit resistance.
(3) Altering the number of poles on the stator.
(4) Altering the frequency of the impressed electromotive-force.

Of these methods the second has been found to be perhaps the least complex. The variation in speed by this method, however, is accomplished only at the expense of the accompanying losses through the resistance inserted. As to efficiency, the last two are the more desirable, but they have other drawbacks in the way of control which incur considerable expense and a rather complicated system. In the fourth method it is evident that some form of frequency-changer must be used, and hence a great additional expense is necessary to make the installation complete.

The Rotary Converter.

A rotary converter is a machine possessing one field and one armature, and in general appearance is similar to a continuous-current machine, inasmuch as the ends of the armature winding are led to a commutator on the one side. There is, however, this difference, the machine also possesses three

or four slip-rings—on the side remote to the commutator—to which taps are led from equidistant points on the armature winding. When brushes are placed upon the slip-rings and polyphase currents are supplied to the armature the machine runs as a synchronous motor, and so long as the armature revolves a direct current may be taken from the commutator at the opposite side. The windings on the armature of a converter are closed; thus the alternating current side is necessarily delta connected. The winding is such that each slip-ring must be connected to as many taps leading to the armature as there are pairs of poles. A converter may be supplied with direct current through the commutator, and polyphase currents be taken from the slip-rings, for in this case it runs as a continuous current motor. When used in this manner it is termed an ***inverted converter***, the term ***rotary*** being usually applied to a converter when it receives polyphase currents and supplies continuous current.

Converters have a variety of uses; as a means of converting polyphase currents into continuous currents the rotary is a useful adjunct in distributing installations in connection with electric traction systems, electrolytic processes, and in charging storage batteries We need here only refer to some of the characteristic features of the rotary converter, one of the most peculiar being the wave-form of the effective current flowing through the armature conductors. A moment's reflection makes it evident that the effective armature current is composed of two currents, one superimposed upon the

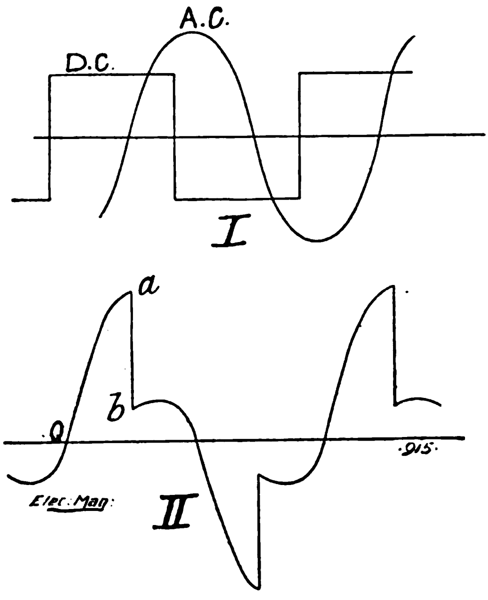


Fig. 4.

other, as shown in Fig 4 *I*; one is the alternating current which is supplied to the armature, and the other is that due to the current taken from the commutator on the direct-current side. The result of this condition will be a flat top or a rectangular lobe on the direct-current side, and a sine wave on the alternating-current side. Since both of these flow through the armature, curves may be plotted separately for each. These currents will not be phase, the zero-value of that on the direct-current side taking place before the alternating current supplied to the slip-rings passes through zero. This condition causes an irregular wave-form which has a peak top, and which when plotted gives the wave shown in Fig. 4 *II*. It will be noticed that when the alternating current has reached the value ***a***, there is a sudden drop. which nearly reaches zero. At this point the alternating current which is entering through the slip-rings (except a small portion of it) passes directly to the commutator brushes.

The effective value of the current which is taken from the direct-current side is evidently made up of maximum values of the alternating-current wave. The effective value of the alternating electromotive supplied is therefore 0.707 times that of the direct-current. This relation does not hold true for a three-phase machine, but it will be 0.613 times the direct-current side. These values are not always found to be exact in practice, the cause being due to a number of inherent conditions, such as (*a*) irregular wave-form of alternating-current supply; (*b*) position of direct-current brushes on commutator; (*c*) field excitation; (*d*) distortion of field-flux; (*e*) drop in armature; (*f*) conditions of regulation.

Rotary converters are not suitable for high frequencies, except very serious mechanical difficulties be removed. The limit of frequency is due solely to these mechanical difficulties, which apply particularly to the commutator. When a machine is designed for a certain frequency there must be a limiting value of the peripheral speed of the commutator. The nature of the commutator is such that the speed limit must be kept within the range of safety. The general dimensions of a commutator are determined by the voltage and the output. The voltage between segments in well-designed machines is limited to about fifteen volts. The greater the frequency the greater will be the number of poles, and (other things being equal) the greater also will the voltage of the machine become. Therefore, more segments will be needed in order to maintain a safe difference of potential between segments. This will, of course, increase the peripheral speed of the commutator beyond its safe limit. Rotary converters are built for frequencies

as high as sixty cycles, but they are large for their output, and hence costly. High-frequency rotaries would, therefore, be so costly as to prohibit their use, not considering the mechanical objections involved. Rotary converters may be started in exactly the same manner as synchronous motors. They may also be started from the direct-current end, and after synchronism is attained may be put into normal condition with the supply circuit by means of suitable switches.

Some Difficulties in Getting On.*

By J. SWINBURNE.

THE first difficulty is to know what equipment is necessary, and how to get it. The difficulty is much greater, however, in the case of a young man, because he has probably the vaguest idea of what his life's work will be, and that idea time will show to be quite wrong. A man who has a speciality of electric waves, gets his first appointment as inspector of meters to an electric light company, and so on. The special knowledge may never come in useful, but the chances are that in the blind stumblings we call our careers, a specialty may be very valuable.

One of the great difficulties is to keep knowledge in a polished state ready for immediate use. Probably the only thing to do is to treat knowledge as a huge district into which one's life is long enough to make some very little roads. From each main road there are branch roads, and from each branch road little paths, and so on to an infinite extent. Many places can be reached by several paths. Each road or path gets obliterated by weeds if it is not constantly trodden. Life is too short to make many roads or paths, and very much too short to keep many of them in order by constant use. The best thing then is to keep one or two main roads clear, and remember where the branch roads and paths are, and go over them again when needed. To go back to plain speaking, the great thing is to master a certain number of broad fundamental principles which give a starting-point for refreshing old knowledge or acquiring new. For instance, in physics, the law of conservation of energy and all that follows from it; the principles of the kinetic theory of gases; the ideas of lines or tubes of force; the principle of the interlinked circuits; the principle of the growth of entropy in all thermo-dynamic changes.

It is often said that the pursuit of knowledge has a nobility of its own. But what knowledge? You may find out what all the numerals in *Bradshaw* add up to; or who was Napoleon's great aunt; or what Mary Shelley ate; or who really wrote the tune of "God Save the King," or the Letters of Junius; or who really started the kinetic theory of gases. In each case you gain knowledge. But you will say, what is the use of such knowledge? Your question at once commands the answer. No knowledge is worth obtaining for its own or any other sake, unless it is or will probably be useful to man.

I would earnestly urge any of my hearers who has the idea that there is something noble and superior about "Raw Science," or who thinks little of business men, to get rid of all such notions if he hopes ever to get on. If you look round the electrica industry, or round the industries generally, who are at the top? Always the business men.

A man's value to the world at large may generally be roughly estimated by the income he earns. Where position is earned at the same time, the money income is in proportion less for a given usefulness; but taking such disturbing elements into account, the rule is broadly true. The business man comes out far away above the engineer. He employs the engineer; the scientific man is his servant. Just as the raw scientist looks down on the engineer, and the engineer looks down on the business man, so the business man has a contempt for the engineer; and the engineer in his turn looks on the raw scientist as an unpractical crank.

If you examine the large industries you will, as I say, find the commercial or business man with little or no technical knowledge at the top of the tree. If you confine your attention to engineers, you will find the engineers who make the biggest incomes and occupy the most important and responble positions are those who have most business or practical knowledge. Our leading consulting engineers do not spend a large portion of their lives plotting curves, counting electrons, or even making anything more than arithmetical calculations. They spend their time dealing with large questions on purely commercial lines; and, as a rule, the bigger the engineer, the more he knows about practice and business, and the less he knows about text-book science. I do not, for a moment, mean to say that text-book science is not of priceless value; of course it is; and the more scientific knowledge you or I, or still more, the leading engineers have, the better; but most of us suffer from too little common sense in proportion to our scientific knowledge.

* Abstract of address to the students of the Institution of Electrical Engineers.

MANUFACTURERS' Section

A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section at end of Magazine.

Some Specialities of the Electric Controller and Supply Company.

In no field of electrical enterprise is there greater scope than in that offered by apparatus which can be classified under the head of accessories to heavy electrical machinery. At one time it was a common practice for manufacturers to make up the accessories for their more bulky products as they were required. As a consequence the design of this apparatus received little or no attention, and when put into operation gave constant trouble; for example, one might compare the massive proportions of a motor or dynamo with the flimsy framework of starting-switch or rheostat, to the distinct disparagement of the latter. Either dynamo or motor was eminently satisfactory in itself, but in conjunction with its despised member the skill and thought expended on its design were rendered futile. It is only within recent years that a bitter experience with accessories has forced manufacturers into providing special departments for their production, but even now the high standards of excellence noticeable in the heavier types of machinery are still wanting in those smaller but none the less important parts which go to make up the system as a whole. Our American and Continental neighbours have taught us many lessons in this particular; and having recently had an opportunity of observing the work of a well-known American house in the marketing of high-class accessories, we take the opportunity of presenting our readers with some short account of its specialities.

The Electric Controller and Supply Company, Cleveland, Ohio, as its name implies, devotes itself specially to the manufacture of controllers and their accessories. Among the latter are a number of novelties which, though they do not fill the same wide field of utility, are none the less valuable in their particular sphere, and we should think they would form very valuable adjuncts to an important section of electrical manufactures.

Controllers.—Quite a number of designs of controllers are exploited by the firm. A popular form is the Dinkey ventilated type, this being the embodiment of six years' progressive experience in meeting the extremely severe requirements of steel mill service. It is equipped with a straight lever motion, the operating handle surmounting the box of resistances and contacts, the former being inside the box and the latter on the outside. The contacts are arranged in a circle and are swept by an arm with renewable contact fingers and magnetic blow out at each end. The entire arrangement is exceedingly compact,

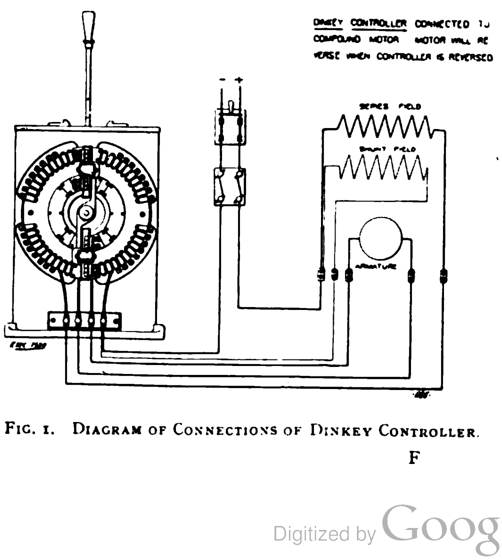


FIG. 1. DIAGRAM OF CONNECTIONS OF DINKEY CONTROLLER.

and from both electrical and mechanical standpoints is substantially constructed, as will be noticed in Fig. 1, which gives a diagram of connections for a controller and a compound wound motor. Type U_2 illustrated in Fig. 2 is a circular controller designed for the operation of cross-travel motors on travelling cranes. It will be noticed that the contact plates are of large area and readily renewable, this operation being possible without disturbing the rest of the controller. As in the previous case, this is an extremely compact device, and it can either be operated drectly or at a distance. These controllers are not designed for continuous operation. They are rated conservatively at one minute's operation on the first and second steps, two minutes on the third and fourth steps, three minutes on the fifth and sixth steps and indefinitely on the seventh step. They will safely stand a momentary overload of 300 per cent. and intermittent starting. The resistance units are supported by the slate face of the controller, the units themselves being wound on a heavy tube of asbestos, having a wrought-iron core. On sizes up to 50 amperes fingers and contact buttons are of drop forged copper. Each resistance unit forms an electro-magnet of which the iron rod is the core. When a current passes through the coil the core becomes magnetised with one pole on the centre of the contact button. This arrangement provides the necessary magnetic field for rupturing any arc formed at the contacts. By this neat method the addition of auxiliary blow-out devices is unnecessary. A smaller size and somewhat smaller design, designated type "U" is also manufactured. In this case the contacts are of hexagonal shape, screwing into the end of the central rod of the resistance unit. These controllers are furnished in sizes up to 20 h.p. and of pressures between 110 and 500 volts. Renewals are all standardised and can be furnished on short notice. In remote districts special repairing sets can be carried so that renewals can be thus readily effected. Fig. 3 illustrates type C controller. From this it will be seen that while the operating handle has a straight motion the controller contacts are arranged on a drum after the style of a tramcar controller. The resistance grids are carefully packed at the back of the frame, and it will be seen that ample space is left for the addition of further resistance grids as required. Other controllers made are type C^1 and type B. The former is somewhat similar to the Dinkey design, but is slightly smaller. The resistances are cast grids so constructed that any individual grid can be readily removed without disturbing other parts of the controller. Type M.T. controller has been specially designed for use in steel rolling-mills. Since the steam-engine has been displaced by motors there has arisen a considerable demand for special controller apparatus for these mill motors. The conditions under which they work are of so arduous a character that no ordinary type of controller could not successfully meet them. In the roller tables used in steel mills for instance, the motion is very frequently and rapidly

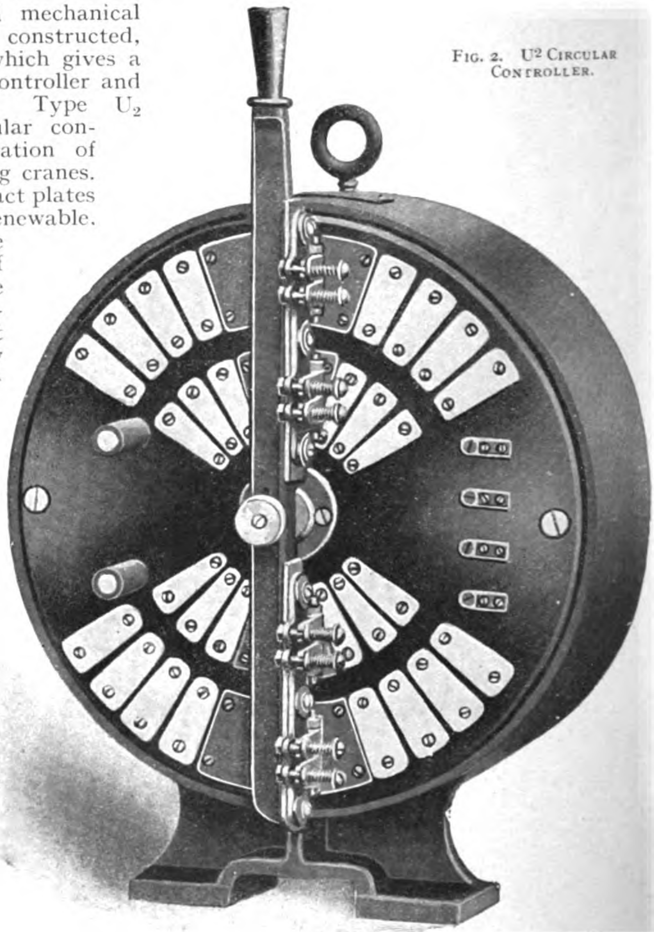


FIG. 2. U² CIRCULAR CONTROLLER.

reversed, in some cases reversal from full speed in one direction to full speed in the reverse direction occupying but a few seconds. Many attempts at using manually operated controllers for such motors have been made, but with very little success. As a rule the operator cannot be relied upon to invariably cut out the controller resistance at a speed which gives the best results, and should the controller be operated too rapidly either the motor or gearing will be damaged. In some cases so much trouble has been experienced in this respect that recourse has been had to steam-

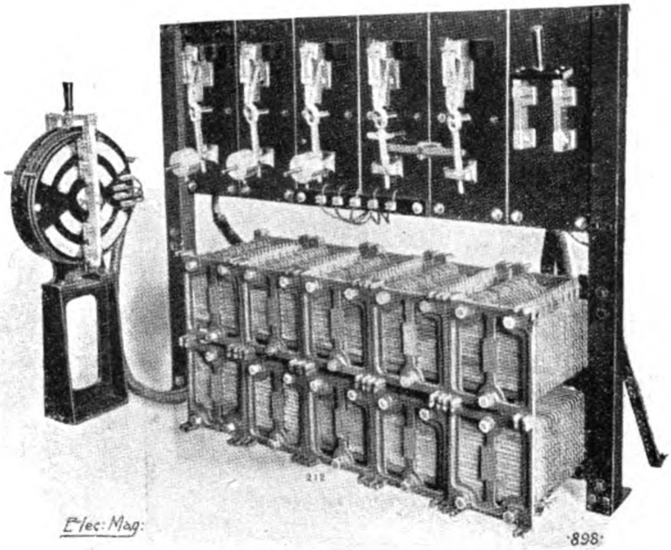
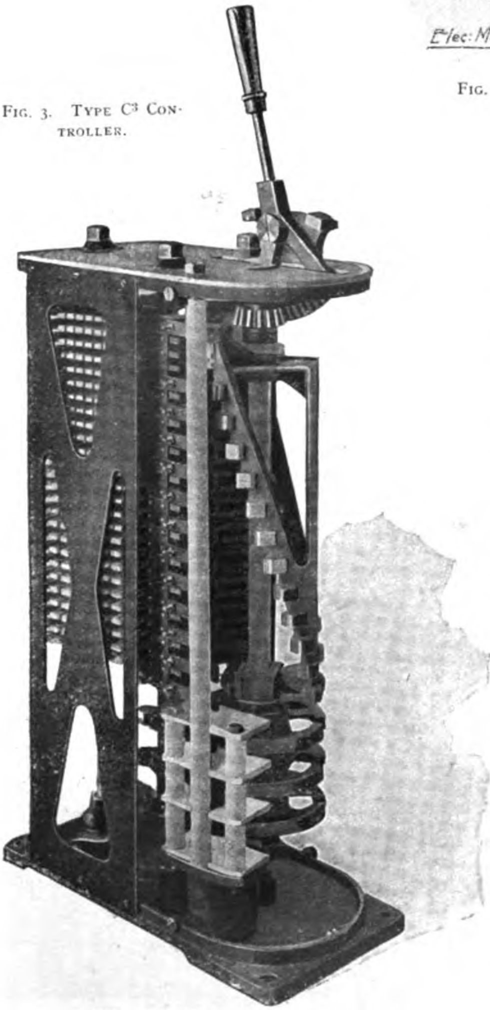


FIG. 4. TYPE M.T. CONTROLLER MAGNETIC SWITCHES AND RESISTANCES.

FIG. 3. TYPE C3 CONTROLLER.



engines. With the type M.T. controller, however, matters are so arranged that a given motor may reverse a piece of machinery just as rapidly as is consistent with the strength of the machinery, but no more rapidly. By this means the motor is protected and relieves the gearing and other parts of the machinery from undue mechanical strains as well as reducing the general wear and tear. The problem has been divided into two parts. First, the absorption and dissipation of the energy of the motor or armature and attached moving parts due to their forward motion. Second, the acceleration of the mass of the armature with the driven parts in the reverse direction. In the M.T. controller this division of operations is successfully accomplished, the energy due to the forward motion being absorbed by a cast-iron resistance, and the armature brought to rest through working as a generator before current can be applied for acceleration in the opposite direction. This action is automatic and entirely independent of the operating controller. The absorbing resistance is proportioned to prevent overloading the motor. Similarly the starting resistance is so proportioned as to limit the initial flow of current from line to motor, and this resistance is automatically cut out by a series of magnetically operated switches. These are inter-locked so that current is kept within prescribed limits during acceleration. The operator meantime controls the motor speed. No matter how rapidly the operator reverses his controller he cannot injure the motor or attached machinery. Fig. 4 shows the

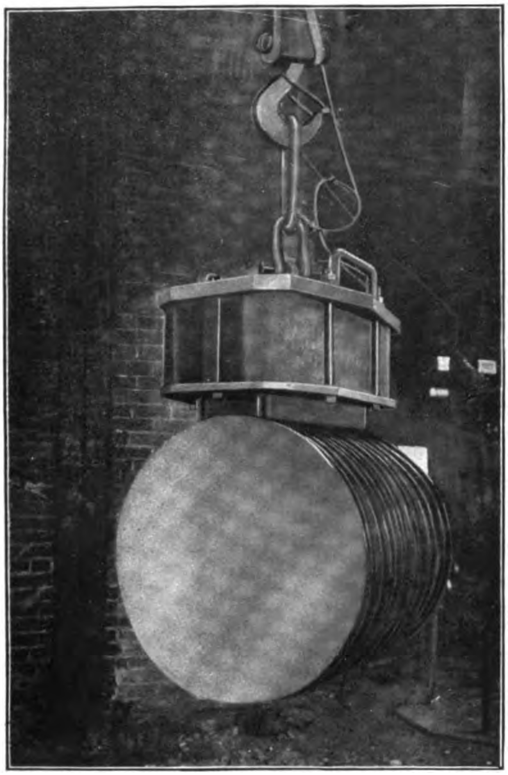


Fig. 5. Magnet Lifting Boiler Heads on Edge.

complete equipment, including operating controller, magnetic switches, and resistance.

Lifting Magnets.—Lifting magnets have established a special field for themselves in the modern machine shop and mill. They may in fact be said to have become indispensable. They are very widely used in America, but have not yet become very popular in this country. The Electric Controller and Supply Co. make several special types, one of which we illustrate. Fig. 5 illustrates how, with a very small contact area, a comparatively heavy weight can be raised. To meet such requirements special forms of magnets are necessary. A magnet which would handle five tons in an ingot might not handle 500 lbs. in thin plates. In each case the operating conditions must be understood with special reference to the form and range of material to be handled. We need hardly emphasise the importance of this extremely simple mode of raising heavy weights. It must be understood that there is a limited field of utility for these devices, but they are capable of working wonders in that field. The importance of handling material with economy and despatch is becoming more pressing, and any device, particularly if it be of a simple character, should be welcomed to accomplish this end.

Magnetic Switches.—The magnetic switch has conclusively proved its utility, and is now finding a permanent place where manual switches have hitherto been exclusively used. The advantages of controlling any piece of electrical apparatus from a distance by conductors and switches of small section have been some time in making themselves felt. Now that engineers are on the right side of experiment, however, we are apt to wonder why the magnetic switch has not made its way earlier into the sphere of electricity control. In dealing with heavy currents some such device is of great value in that large cables are not needed outside the controlling gear, which may with further advantage be placed close to the machinery it controls.

In Fig. 6 the Electric Controller and Supply Company's gravity type of magnetic switch is shown, this being built for capacities from 1 to 150 amperes. From the solenoid plunger the switch contacts are hung, and when energised, the coil draws up the switch arm, thus closing the circuit. Main copper contacts carry the main current, and auxiliary carbon tips take care of the

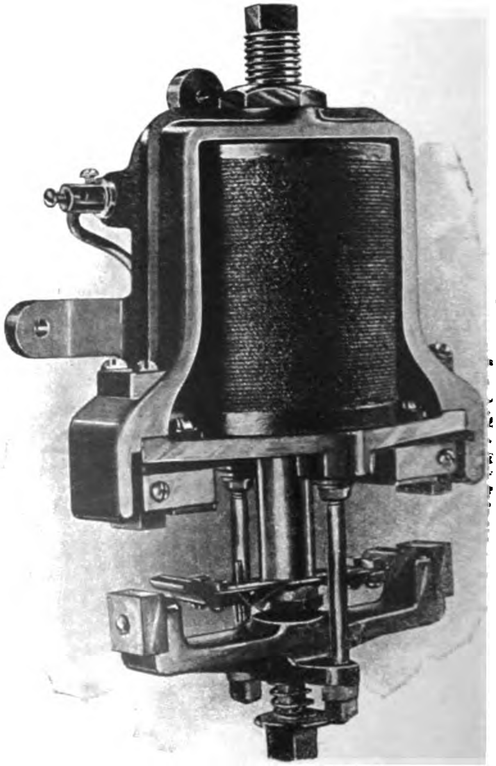


Fig. 6. Gravity Magnetic Switch.

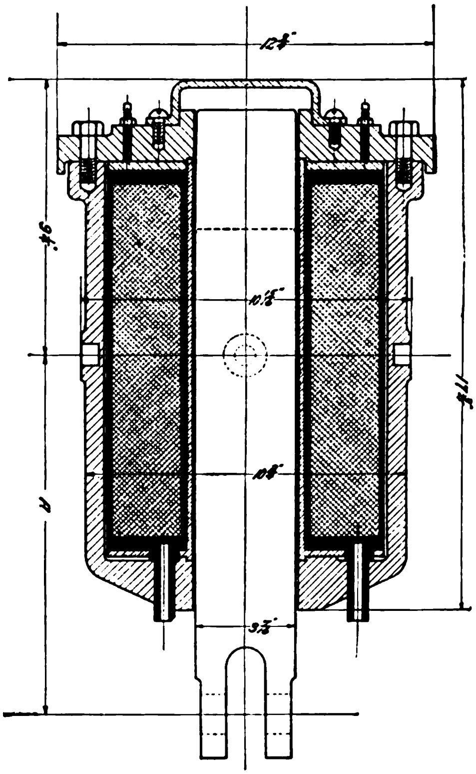


Fig. 7. Electro-Magnet. Section through Coil and Core.

arc formed at opening. Further, a heavy magnetic flux is directed in the path of the arc, by the special construction of the solenoid and frame supporting it. A clapper type of switch is also made, the magnet being horizontal and exerting a direct pull on a vertical switch arm pivoted at its lower extremity. The upper end carries the contact brush which is protected by a carbon break between the poles of a powerful magnet. Switches of this type may be seen in Fig 4, in conjunction with M.T. controller.

Solenoids and Electro-Magnets.—Side by side with the development of magnetic switches has arisen a demand for Ironclad Solenoids for use with brakes and for applying mechanical clutches, especially where one motor is used for two motions. The design of such devices has received special attention by the company, and a type of magnet evolved to meet most requirements. This is known as the Magnetic Cushion Type, and embodies several unique features. The "cushion" is obtained magnetically, the curves of tractive force being almost a horizontal line, obviating rapid acceleration of the plunger towards the end of its stroke. To allow for inequalities in alignment, the solenoid is specially hung on two pins pivoted in an outer ring, which is in turn hung on bearings forming the supporting standards. This arrangement will be understood from Fig. 8.

Magnetic Clutches.—Engineers are all familiar with the numerous clutches, friction, claw and other types in more or less common use on shafting. The magnetic clutch is, however, by no means common, but its employment is none the less a matter for commercial enterprise, as is evident from the types which the Electric Controller and Supply Company are successfully marketing. Unlike many clutches similar in principle, their design is devoid of levers and toggel-joints, and sources of constant trouble are thus removed. The clutch is perfectly balanced, and there is no end thrust to cause wear and power loss. The reversing type usually fitted to planers comprises two annular electro-magnets mounted loosely on the driving shaft and driven in opposite directions through gearing by the motor. The driven member consists of a double disc carried between the two magnets on the driving shaft, and capable of slight parallel motion on feather keys, so that it can be attracted and driven by either magnet. The driven member is also fitted with a ring of friction blocks, adjustable for wear, and serve to maintain a constant working air gap between driving and driven elements, thus precluding all possibility of seizing. A simple switch operates the clutch, which consumes on an average about fifty-five watts. In conjunction with planers the device

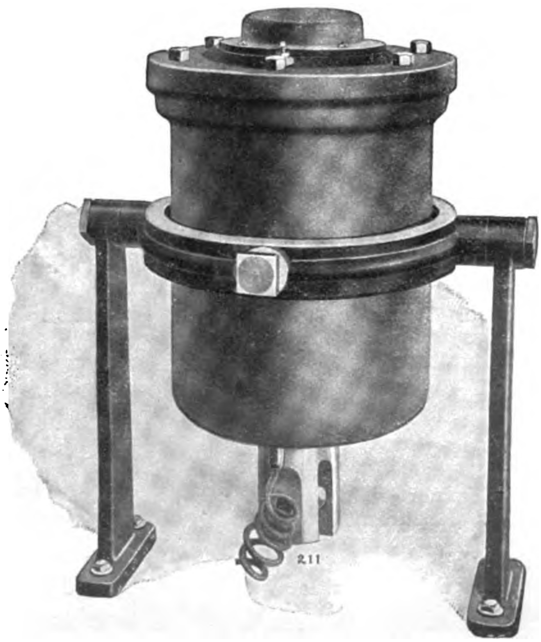


Fig. 8. Complete Electro-Magnet and Swivel Mounting.

permits of delicate adjustment and smoothness of operation.

The above are the chief specialities of the Electric Controller and Supply Company, who are to be complimented on having so varied a selection of products under their control. Naturally the bulk of the output is in controllers, but with the other specialities a wide field of utility is entered. There seems to be no reason to doubt that such devices are proving their value, and establishing claims to even greater attention, and in thus launching out on special lines and laying down standards in electrical accessories, the company may well be said to have done permanent good.

As typical of its business methods, we may quote the following instance. The company posted a notice in its drafting-room recently to the effect that it was intended to relieve Mr. Pirtle, who has been in charge of its Exhibit at the Louisiana Purchase Exposition since the opening of the Fair. As a means of selecting the man best suited for this work, it decided to inaugurate a contest among its draftsmen, allowing all to enter. The contest consisted of two written articles—one on the company's Improved Direct Motor Drive for Planers and the other on their Mill Table Controller.

All articles presented to be judged from the following standpoints:

(1) The clearest description of the functions and operation of the various switches, circuits, &c., from an engineering standpoint to count forty points.

(2) The best statement of the advantages arising from the use of the apparatus viewed from the standpoint of the customer to count thirty points.

(3) The best composition from the standpoint of rhetoric and grammar to count thirty points.

All work on these articles to be done outside of office hours.

The four judges consisted of A. C. Eastwood, Engineer, R. I. Wright, Asst. Engineer, Harold McGeorge, General Manager, and J. H. Hall, Chief Draftsman. Competition was keen and a number of interesting papers were presented, requiring long and careful deliberation on the part of the judges. A decision was rendered in favour of Mr. Geo. W. Magalhaes, who was formerly a student of Case School of Applied Science and later a graduate of the Columbia University.

Modern Methods of Motor Manufacture.

A Visit to the Morris-Hawkins' Works.

Now that public Companies and Corporations owning electricity stations are supplying electrical energy at such low rates for motive power, a large and increasing demand has sprung up for electric motors for industrial purposes; this demand has naturally attracted many competitors to the field of electric motor manufacture, and it is not, therefore, surprising to find that the cost of production has been reduced enormously.

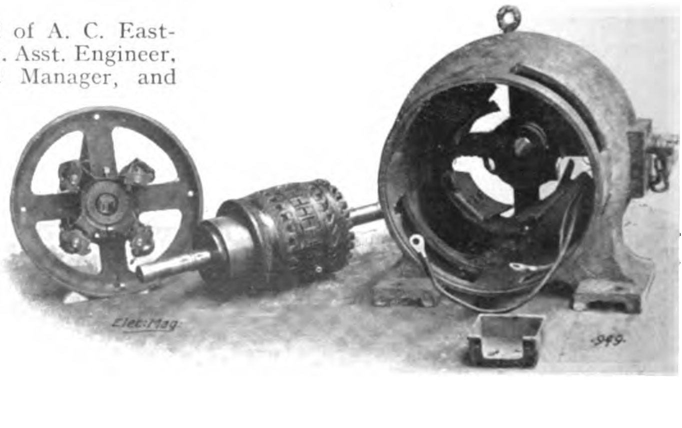
The lower prices now obtaining are due to:

(1) Improved designs.

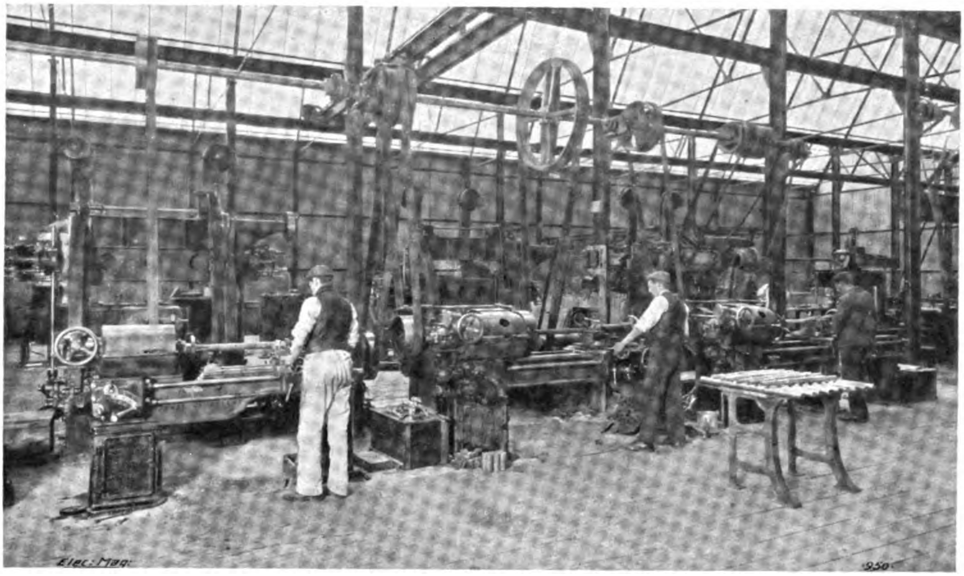
(2) Standardisation of parts.

(3) Factories equipped with special plant for their manufacture.

The progress made during the last seven years in the manufacture of the direct-current motor is due chiefly to the general introduction of armatures having slotted cores, and to the application of carbon brushes for the collection and commutation of the electric current. The slotted armature has considerable advantages in electrical as well as mechanical respects when compared with armatures of the smooth core type. The armature coils, being laid in slots below the core surface, are removed out of the strong magnetic field and are therefore protected from any appreciable torque strains, such strains being taken up by the teeth of the armature, while a further advantage is gained, inasmuch as the windings are also protected from mechanical injury. The radial depth of the air gap between armature core and magnet can be kept smaller than with the smooth core type, effecting a reduction in the field magnet copper, and also in a saving in the excitation



Morris-Hawkins' Motor Dissected.



Special Lathes used in Morris-Hawkins' Works. Boring Mills in Background.

energy required for the production of the necessary magnetic lines.

By the use of carbon brushes the commutation of direct-current motors is vastly improved, although much credit is due to the advanced scientific knowledge which gives a clearer conception of what takes place during commutation, so that we can now rely on obtaining sparkless collection. The application of carbon brushes is unfavourable when considered from the standpoint of efficiency, for the electrical resistance between the brushes and commutator face is considerably greater when carbon is used in preference to copper, consequently the commutator losses are greater in motors fitted with carbon brushes. Such losses appear in the form of heat, and to secure its proper diffusion a certain surface is necessary, and therefore we find that motors fitted with carbon brushes have comparatively large commutators so as to ensure that the temperature of this part of the machine shall come within the recognised limits.

We have previously stated that from the electrical point of view considerable gain was made by the introduction of the slotted armature due to the smaller excitation energy required, but this gain is to a considerable extent mitigated by increased losses due to carbon brushes, so that in electrical efficiency very little net gain has been made. Motors built as far back as seven years ago, reached, in the larger sizes, an electrical efficiency as high as 94 per cent., leaving very little margin for improvement in this respect. Except in very small machines the two-pole motor has become almost obsolete, for reasons which are not far to seek—it was found that the multipolar type effected a considerable saving in the weight of the field magnets, and when built in circular form is certainly a most economical design from the machine-shop point of view. This design also allows of economies being effected in the armature itself, inasmuch as a multipolar winding tends to shorten the copper end connections. The adoption of what is known as the barrel-type winding allows free scope for ventilation axially through the laminated core, and recent designs provide still further ventilation radially by means of air ducts.

The general use of the slotted armature was instrumental in evolving the machine-wound coil, which plays such an important part in the economical and rapid production of the armature of a motor. These coils are now formed exactly to the required shape for assembling on the core, such work hitherto having been done entirely by hand labour. The ingenious power-driven taping machine also plays an important part, as the machine-wound coil can now be served with tape insulation in a thorough and expeditious manner.

From the foregoing remarks it must be evident that great care has been given to the design of the electro-motor to bring it to its present state of perfection, so that such improvements as are still possible to obtain must consist in rational design and construction, having regard to the

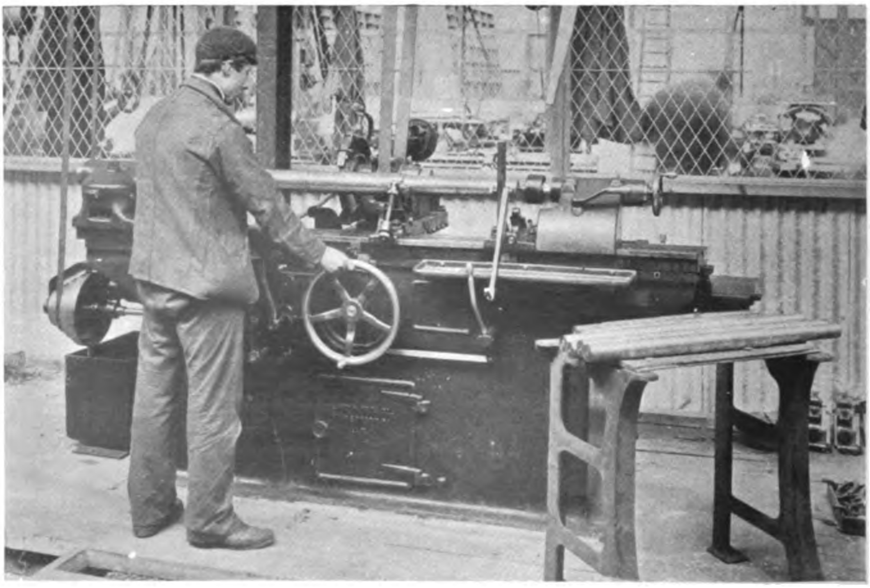
Armature Coil-taping Machine in Use.

them to carry a large stock, can successfully do business.

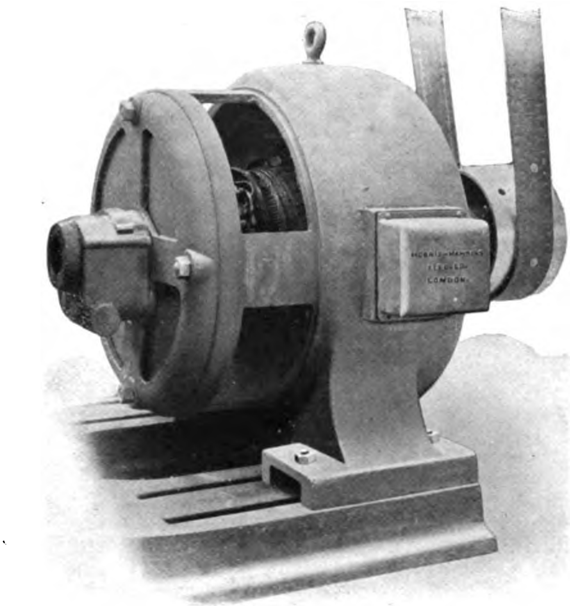
The Morris-Hawkins' Electrical Co., which has been organised by men of large experience in the manufacture of electrical machinery, has established new Works at Dagenham, near London, and freed from obsolete designs they have entered the field with a new and up-to-date line of motors, manufactured in twelve standard sizes, giving a range of from 1 h.p. to 100 h.p. Standardisation has been carried to a very high state of perfection, the machined parts being made strictly to limit gauge and templet, and the jig system adopted in the manufacture of component parts, thus ensuring perfect accuracy and interchangeability.

demand for a motor which shall be reasonable in price and also give high economy in working. Standardisation has been rendered possible by the increased demand for motors permitting of standard sizes being manufactured in large quantities, and owing to the prompt deliveries usually required only those firms who standardise their manufactures in such a way as to enable

A special plant has been put down for the manufacture of these motors. The field magnet, as will be seen, is circular in form, with machined recesses to permit of cast-iron end brackets being laid snugly



Emery Grinder in Use Finishing Motor Shafts.



Complete Morris-Hawkins' Motor.

into these recesses. The circular cast-iron end brackets are bolted to the magnet frame, and serve both as a protection to the armature and a support for the bearings. Boring and turning mills also have been put down for machining the field magnets and bearing end brackets. There is little doubt that boring mills for all kinds of chuck work are rapidly superseding the ordinary face plate lathes. The advantages of the former are numerous and important, for, not only can work be set up more rapidly on the boring mill, but the operation is performed in a much shorter time, and in a more satisfactory manner. These machines are of the very latest type, and the various speeds are obtained instantly from a gear box attached to the machine tool, and the clumsy overhead counter shaft has been dispensed with. Smaller boring mills of a similar design, but with turret heads are used for machining the armature bearing end brackets.

The steel shafts on which the armature cores are mounted, are turned in a new type of lathe which has given great satisfaction in regard to rapid production of work. The fast head stock consists of a patent variable speed drive, by which the correct surface speed may be obtained for any diameter within the range of the lathe, however small the variation. The hand wheel is conveniently placed so that the workman can get the correct cutting speed without handling the belt. The same operation which changes the speed moves an index to show at all times the diameter being turned. As will be seen from our illustration no counter motion is required with these lathes. The greatest care is taken in obtaining a highly finished shaft, and all shafts are turned in the lathe within $\frac{1}{1000}$ parts of an inch of the finished size, and are afterwards operated upon in a grinding machine ; also shown. With grinding machines the greatest degree of accuracy is at command, and, as now constructed, they are capable of producing finished pieces, whether accuracy is required or not, in less time than it can be done in any other way, apart from the satisfaction of knowing that motor shafts finished on a grinder are true round, and will run with less friction than those which are finished by other processes. But perhaps the most important part of the motor is the commutator.

The commutator has received most careful attention. The bars are made of the best hard-drawn copper, uniform in section, insulated from each other, and from the shell with mica. After assembling they are submitted to hydraulic pressure of from eighty to one hundred tons, and are subsequently baked, a process which gives them true position and further shrinkage does not take place. For dealing with the commutator bush and clamp rings a special plant has been installed consisting of hexagon turret lathes, which save much valuable time This is economised by the use of specially adapted chucks and fixtures, and of a number of cutting tools set on the turret head, which can frequently be put in operation at one and the same time, and by the saving of time occupied in changing tools as is done on an ordinary lathe. Further advantage is obtained by the elimination of all measurements, whilst the work is in progress by the use of automatic trip and dead stops.

The Morris-Hawkins' motors are built on the principles above described, and are manufactured by the high-class machinery illustrated. The works, as a whole, are carefully planned, and should produce reliable apparatus economically and with rapidity.

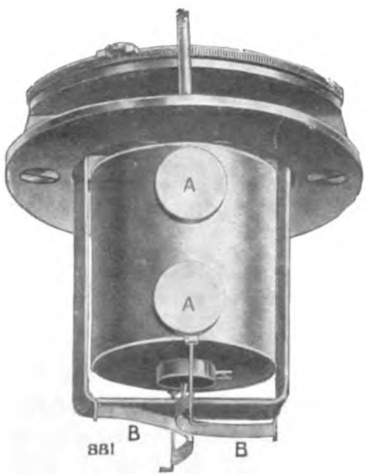
STANDARDS IN INSTRUMENTS.

Some fifteen years ago the firm of Crompton and Co., of Chelmsford, introduced into engineering practice the "potentiometer" as a normal instrument for verifying other

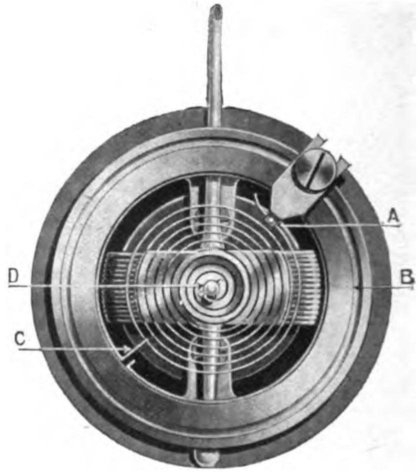
instruments and for making measurements on direct-current machinery wherever a higher degree of accuracy was required than is obtainable with ordinary commercial methods. In a system they have recently introduced for the standardisation of ordinary switchboard and portable instruments, Messrs. Crompton and Co. have taken another step in the direction of making electrical engineers independent of instrument makers for the calibration of their apparatus. We have received from them an advance proof of a pamphlet describing this system and a method of constructing instruments which admits of its being carried easily into practice. The general idea of the scheme is shortly as follows:

Regarding a voltmeter as an instrument for measuring the very small current carried by a high resistance connected between the busbars, Crompton and Co. treat the indicating instrument as a milliamperemeter and calibrate it in milliamperes. They construct all the voltmeter resistances to pass the same current (the value of which they have fixed at fifteen milliamperes), at the normal pressure which the voltmeter is intended to indicate, and thus all voltmeters become milliamperemeters for reading a current of fifteen milliamperes. Now a properly constructed resistance is a piece of apparatus which is not liable to change, and, apart from obvious accidents, can be permanently trusted, so that for practical purposes it is sufficient to be able to verify the indicating instrument. If the scale of this is marked in milliamperes as well as with the pressures it is intended to indicate, the instrument can be very easily verified at any time treating it merely as a milliamperemeter.

In the same way the amperemeter is



COMPLETE CELL OF INSTRUMENT.

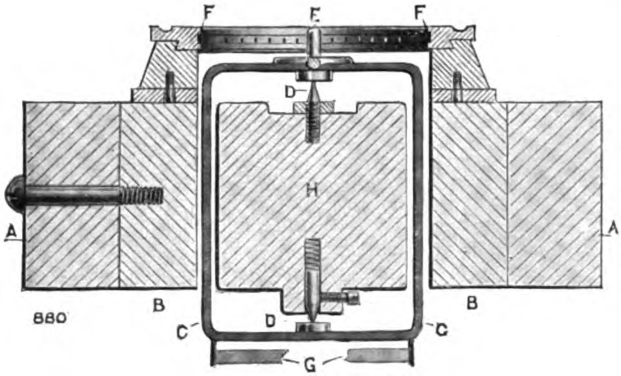


VIEW OF CONTROLLING SPRING.

regarded as an instrument for indicating the small potential difference at the ends of the shunt or low resistance carrying the current to be measured. Crompton and Co. calibrate the indicating instrument as a milli-voltmeter, and adjust every amperemeter shunt to give the same potential difference (for which they have chosen the value .075 volt) when carrying the full current for which the shunt is rated. The indicating instrument then becomes a millivoltmeter reading to .075 of a volt. As with voltmeter resistances, so the shunt or low resistance of an amperemeter can be permanently trusted, and to verify the readings it is only necessary to verify the indicating instrument treating it as a millivoltmeter. An engineer is then in a position to check the whole of his instruments with great precision if he is provided with means to test currents up to fifteen milliamperes and pressures up to seventy-five millivolts.

The apparatus required for this purpose consists of (1) a single cell (a Leclanché dry cell is very convenient); (2) a rheostat to regulate the current; (3) a standard instrument to read up to fifteen milliamperes and seventy-five millivolts. A convenient pattern has been designed for (2); for (3) Crompton and Co. supply a small instrument which they call a gauge, having a resistance of five ohms and a single fiduciary mark instead of a scale. This instrument is adjusted so that the current of fifteen milliamperes or a pressure at the terminals of seventy-five millivolts brings the pointer exactly to its mark, and with these pieces of apparatus all switchboard instruments can be verified.

Messrs. Crompton have gone a step further than this by a very ingenious and novel



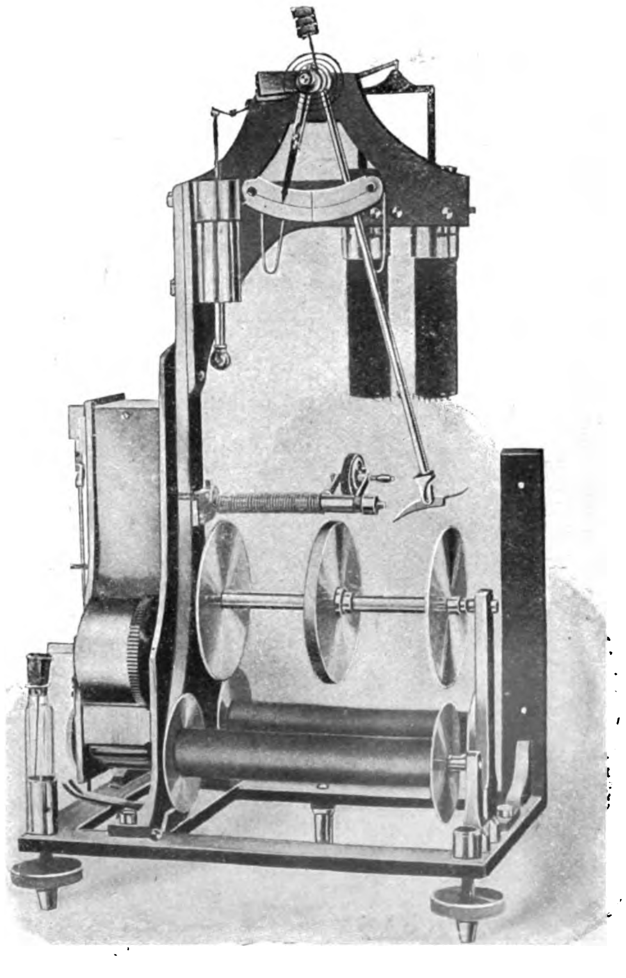
View of Coil and Supporting Points.

method of mounting the moving coil, the control spring of which is readily accessible and can be easily regulated. In fact the regulation and adjustment of this part, which, in most instruments of the class, is too delicate to be handled except by an instrument maker, is quite within the powers of any one with ordinarily neat fingers. Roughly speaking, it is about as complicated an operation as regulating one's watch. The pamphlet that Messrs. Crompton and Co. have sent to us describes the system and operation very clearly and would interest any one concerned with electrical matters.

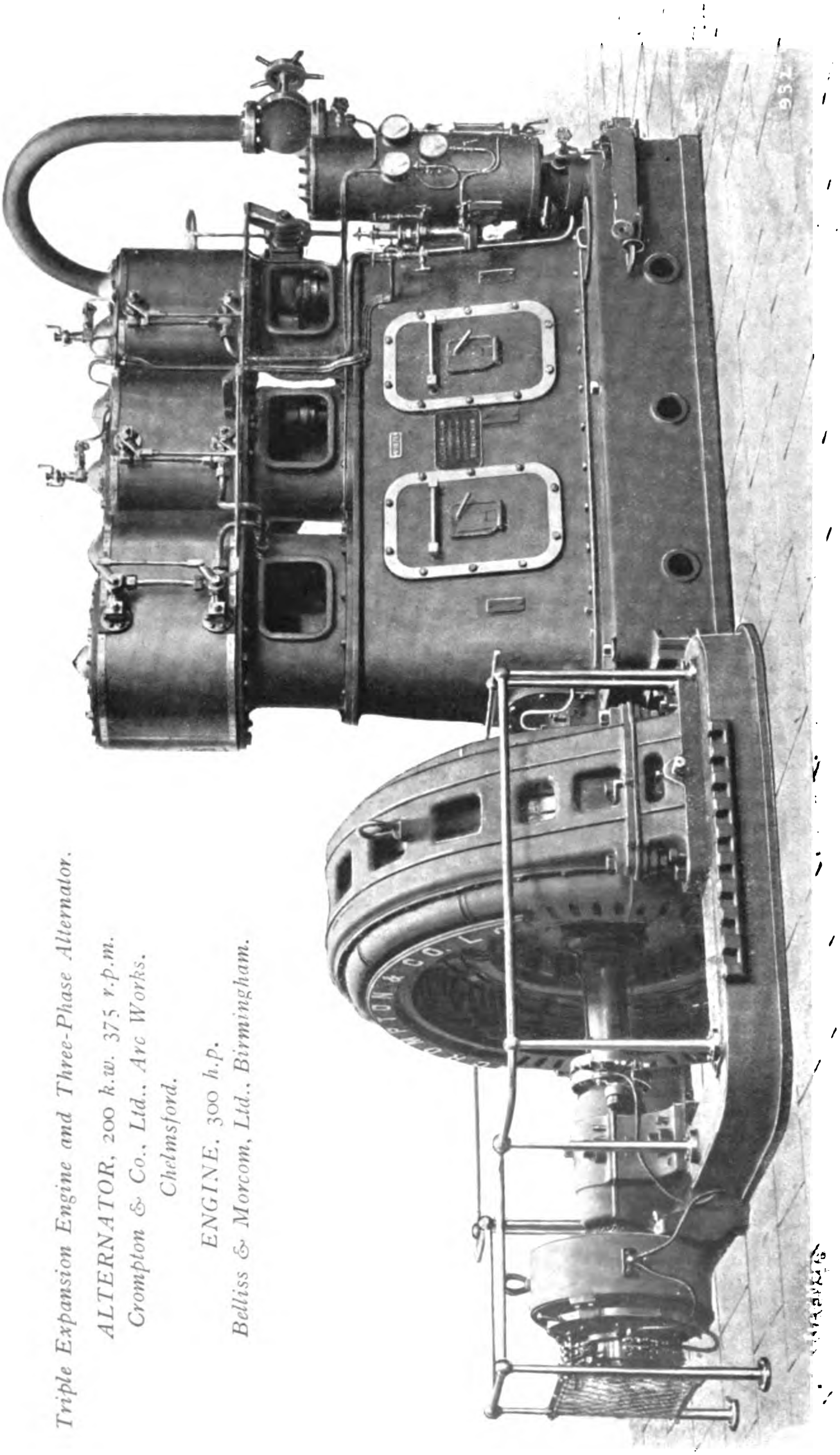
The illustrations we give show the construction of the movement.

RECORDING INSTRUMENTS.

A novel line of recording instruments has been just introduced by J. H. Holmes and Co., Newcastle-on-Tyne. From particulars furnished by the company we understand that two of the chief difficulties experienced with recording instruments—that of driving a continuous band of paper and maintaining a supply of ink for a lengthened period without requiring constant attention have been overcome successfully with their new pattern. The first trouble is obviated by a serrated driving wheel acting on the centre of the paper band, and the second difficulty by a special form of pen carrying a large supply of ink and moving in a straight line across the paper instead of describing an arc. The paper is rewound on a spool after passing under the pen and has, therefore, no tendency to become creased or curl up. It will run safely for at least fourteen days. These recorders are made in two forms, the switchboard type in cast-iron case and the portable type in mahogany case with carrying handle and levelling screws. We illustrate the details of the mechanism of a recording voltmeter, and from this the principle of the instrument and disposition of the parts will be quite clear. The paper is not shown Lack of space will not permit us to give further details.



Interior of Recording Voltmeter.



Triple Expansion Engine and Three-Phase Alternator.

ALTERNATOR, 200 k.w. 375 r.p.m.
Crompton & Co., Ltd., Arc Works.
Chelmsford.

ENGINE, 300 h.p.
Belliss & Morcom, Ltd., Birmingham.

Standard Types of Electrical Apparatus. VI.

The World's Electrical Literature Section at end of Magazine contains a classified list of all articles of interest to Central Station men. Consult it and save yourself much valuable time.

Notes on the Working of Central Station Plant.—VI.

By F. H. CORSON.

(Continued from page 528.)

On Condensing.

THE considerations which must determine whether or not it is profitable to instal condensing plant in a station, and, if so, what type is most suitable, do not come within the scope of these articles. It is usually a comparatively simple matter to decide these points when the local conditions such as supply, cost, and quality of water and extent of plant &c., are known. The aim of these notes is the attainment of the best results in the actual use of whatever plant is installed, and it is now proposed to deal with the question of the most economical vacuum, without, as far as possible, touching the means of attaining it.

The discussions which so frequently find place in technical literature on the value of every extra inch of vacuum above 24 in. or 25 in., while most interesting from an academic point of view, are unfortunately not so valuable from the commercial standpoint of the station engineer. At the outset it is safe to say that unless each engine is provided with its own condenser, and the supply of cold water is very plentiful, a 24-in. vacuum in the engine cylinders when loaded is very rarely reached, and the higher grades up to 27 and 28 in. are quite out of the sphere of practical politics. Again, the economy of the extra inch of vacuum, if it should be attainable, applies only to the steam consumption of the engine, and not to the running of the whole plant. In all cases this gain is accompanied by losses elsewhere which may easily far outweigh it in extent, and it is to the correct adjustment of these gains and losses that the highest success will accrue.

The writer has many times been shown a central condensing plant where the engineer points with visible pride to his 27 or perhaps 28 in., quite oblivious of the fact that by reducing his much-prized vacuum by two or three inches and thus keeping a somewhat higher temperature in the hot-well, he would be able to plume himself with no less satisfaction on an improved cost sheet. The extra cost involved in maintaining a high vacuum is not simply that of the additional water required. To this must be added the cost of pumping, and also the interest on the extra capital called for by the increased size of the pumping plant, and, in many cases, it is to be feared that the economy of the high vacuum is more apparent than actual. The type of condensers must also have a strong bearing on the matter, inasmuch as this is bound up with the question of the advisability of using the condensed steam again as boiler-feed.

Considering first the pros and cons of the high vacuum in its simplest form, we shall neglect the question of boiler-feed, and merely investigate the subject from the point of view of the increased water consumption over that required for the lower.

A considerable amount of uncertainty and ignorance seems to prevail regarding the relative demands for condensing water per lb. of steam, at a 28- as against a 25-in. vacuum, and it may be of interest to compare

the two and to discover the theoretical requirements in each case.

The opinion most frequently met with runs somewhat on the lines that the water consumption is approximately proportional to the degree of vacuum obtained, and hence that 28 in. of vacuum would require something like 12 per cent. or perhaps 15 per cent. more water than would 25 in. A simple investigation will show that this is utterly incorrect. Take the two cases of a 25-in and a 28-in. vacuum obtained on a jet condenser with injection water at 60° F.

A 25-in. vacuum corresponds to a hot-well temperature of 133° F. and steam at this temperature has a latent heat of 1,021 units. Theoretically the amount of water required per lb. of steam condensed is in this case $\frac{1021}{133-60} = 14$ lbs.

Taking the case of a 28-in. vacuum, corresponding to a discharge temperature of 100° F. and a latent heat of ,044 units, the equation is as before $\frac{1044}{100-60} = 26.1$ lbs. water per lb. steam.

Although in practice the above amounts will be quite insufficient, the relation between them holds good, and it is seen that practically 86 per cent. more water is required in the one case than in the other. If the station is not so favourably situated as to be able to obtain enough water at 60° the position becomes worse, and the above cases considered on the basis of condensing water at 75° F. would give 17.6 lbs. and 42 lbs. of water per lb. steam respectively or an increase of more than 140 per cent. for the higher over the lower vacuum. Remembering again that the cost of pumping varies with the amount of water dealt with, an idea of the relative costs under the two conditions is easily formed.

The following table shows at a glance the relationship between the degree of vacuum, the temperature of the injection water, and the amount of condensing water required per lb. of steam condensed under the varying conditions.

Temperature of Injection in Degrees Fahr.

Inches of Vacuum.	50°	60°	70°	80°	90°	100°	110°
23	10.5	11.8	13.3	15.3	18	22	28.1
24	11.3	12.7	14.5	16.9	20.3	25.0	33.9
25	12.3	14	16.2	19.3	23.7	30.9	44.4
26	13.7	15.8	18·7	22.8	29.3	41	68.5
27	16.2	19.2	23.5	30.4	43.1	74	259.
28	20.9	26.1	34.8	52.2	104.4	—	—

Lbs. of Condensing Water.

Theoretical water consumption per lb. of steam condensed under varying vacua and with varying temperatures of injection water.

Approaching the matter now from another standpoint, viz., that of boiler-feed, further investigation is necessary, and it is only in extremely few, if any cases, that this aspect of the question can be neglected. It has been shown above that the difference of temperature of the hot-well from condensers with 25- and 28-in. vacua is 33° F. This means 33 units of heat per lb. of feed-water lost by the maintenance of the high vacuum and involving considerable loss which should be charged against the gain in steam consumption.

With feed-water at about 100° F. something over 1,100 units of heat are imparted to each lb. of water to make steam at 100 lbs. to 200 lbs. pressure. It is thus seen that the maintenance of 28-in. vacuum as against 25 in., where the condenser supplies the water for boiler feeding, involves an extra 3 per cent. in the heat to be given to the feed-water. Obviously unless the better vacuum is the means of reducing the quantity of steam required by as much more than 3 per cent. as will cover the cost of the extra pumping, the balance is on the wrong side.

It is impossible to lay down any hard and fast rules as to the most economical vacuum, *per se*, on account of the extent to which other considerations are involved. The foregoing illustrations will, it is hoped, give an indication of the lines on which investigation should be made, and will serve to draw attention to those details which are more immediately affected by the vacuum, so narrowing down the field of inquiry as to keep it within practical and profitable limits.

Under the head of "Condensing" many interesting side issues are brought up, some of which are decidedly worth inquiry, and many examples of indifferent engineering are exhibited in this connection. It is interesting to note in how many cases the makers of steam-driven condensing plant defeat their own ends by turning the exhaust from their steam pumps into the condenser. The effect of this is undoubtedly to reduce to some slight extent (about 10 per cent.) the steam consumption of the apparatus, but at the same time also to reduce the capacity of the condenser in much greater ratio.

A similar argument applies to the condensing of steam pumps for boiler-feed purposes, a thing which is frequently done in central stations. These are notoriously extravagant in steam, a consumption of something like 100 lbs. per h.p. being about

the average for well-designed single-cylinder pumps. The fact that in this class of apparatus the steam cannot be, to any great extent, used expansively greatly reduces the gain by condensing, so that a large amount of steam is turned into the condenser, and very little gain is achieved in the process. It will be found much more profitable to use the exhaust from such steam auxiliaries for the purpose of heating feed-water, either by direct delivery into the feed tank through an injector in which case all the heat in the steam is utilised, or by passing through the pipes of some form of feed heater.

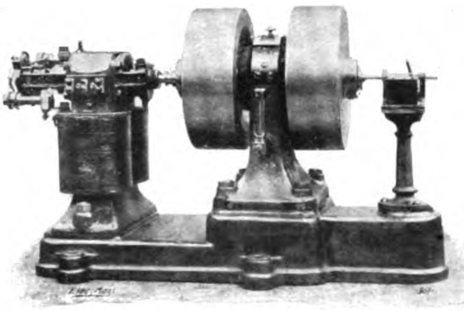
In one case which has come under the writer's notice the exhaust of a 1,200-h.p. steam-driven condenser was coupled up as mentioned above. The steam consumption of the apparatus exhausting to atmosphere was about 2,500 lbs. per hour, and this by condensing could be reduced to about 2,200 lbs. or a saving of only 300 lbs. per hour, while making a demand on the condensing power of the apparatus equal to about 120 h.p. of the engine-room plant. By disconnecting this exhaust from the condenser and turning it through an injection nozzle into the feed-tank, sufficient heat was liberated to raise the temperature of about 3,000 gallons of water per hour something like 80° F., representing a saving of about seven or eight times as much on the fuel bill, as was the result of the former method.

ELECTRICALLY DRIVEN OIL-TESTING MACHINE.

It is very necessary where apparatus is in operation continuously and at medium or high speeds that the highest grade of lubricating oil be used. In large shops, power-plants, and factories where a considerable quantity of oil is required it is very desirable before purchasing to thoroughly test the oils both in order to find out the most desirable oil for the particular apparatus in use as well as to determine whether subsequent shipments are up to the standard determined upon.

A new electrically operated oil-testing apparatus has recently been brought out by the Elektricitats - Aktien - Gesellschaft of Frankfort, which is of more than passing interest. It is possible with this oil tester to accurately determine the frictional coefficient of different grades of oils at varying temperatures. The device consists of a short length of shaft running in a bearing of the ring lubricated type, and carrying a heavy fly-wheel at each end which produces the ordinary pressure on the bearing.

A pin coupling is provided on this shaft in order that the motive power can be uncoupled at any moment while running.



OIL-TESTER AND DRIVING MOTOR.

The apparatus is designed to be driven by an electric motor, by mechanical means, or by hand. For laboratory purposes the machine is arranged with fly-wheels for different bearing pressures and an exact device for measuring the speed. The apparatus when electrically driven as shown in the accompanying illustration, is equipped with a motor having an output of about $\frac{1}{6}$ h.p. at 1,800 r.p.m. The motor is set upon a common base plate with the oil-testing machine and drives the latter by means of a pin coupling.

The mechanically operated device is of a similar construction, having a suitable coupling for disengaging the motive power at the proper time. When the oil-testing machine is hand driven, two small reduction gear spindles are arranged so as to obtain a speed of from 1,500 to 1,700 revolutions per minute at the fly-wheel spindle, a similar uncoupling arrangement being also provided.

When testing a sample of oil about one-half a pint of the lubricant is placed in the bearing, and the motor is started, the fly-wheel shaft being run at full speed for a short time, when the motor is disconnected by means of the coupling, allowing the tester to continue running until it comes to rest. It is only necessary to note the time required for the apparatus to come to rest to compare the lubricating qualities of the various samples, the better the quality of the oil, of course, the longer the shaft will run before coming to rest. When another sample of oil is to be tested, benzine is passed through the bearing to thoroughly clean it, and a blast of air is allowed to pass also, thus obviating the necessity of taking the apparatus apart. This method of cleaning has been found to work with perfect satisfaction after many trials of both ways.

This electrical testing apparatus is fitted with resistance coils for warming the bearing to any desired temperature. A method of determining whether or not the oil is likely to solidify is to place the lubricant between two polished iron plates and lay them to-

gether, when it will be found that if the oil is at all likely to solidify it will be difficult to move the plates against one another after a short time has elapsed. To determine whether the oil is free from acid, it is only necessary to dip a polished copper plate into the sample for a short period of time, and note whether there is any difference between that part of the plate which was in contact with the oil, and that which was not immersed.

VARIABLE SPEED SHUNT MOTORS.

SOME useful hints as to the regulation of shunt motors are given by M. Leblend, in a recent issue of *L' Industrie Electrique*. Increasing the exciting current in these motors generally causes a decrease in speed, but there must be a limit to this effect, or else maximum speed would be realised with no current, which is absurd. A very simple mathematical investigation will show that the magnitude and sign of the variation in speed depends on the amount of field variation and the armature resistance. When the field changes new values are assigned to the back electromotive force, torque, and current, which quantities reach on each other till a final steady state of equilibrium is reached, provided, of course, the motor is properly designed. The momentary variations set up are evidently of the same sign as the permanent ones, and a study of the former is, therefore, of interest. Suppose the field changes from F to nF, where F is any factor, then current in the armature is altered in the ratio U - nE/U - E, E being the primitive back electromotive force, and U the terminal P.D. Thus current increases when the field grows weaker and *vice versâ*. Now since torque varies as the product of field and current, the sign of its variation cannot be determined offhand. The ratio of the new torque to the old is n (U - nE)/U - E, first suppose $n < 1$, then in order that the torque may increase we must have:

$$n > U - E/E,$$

an inequality which is never satisfied when E is smaller than U/2, and in the reverse hypothesis is only satisfied when n is not too small, *i.e.*, when the reduction in the value of the field is not too great. In this case the torque increases with decrease of field for values of n ranging from 1 to U - E/E, and decreases when n is smaller than this quantity. Now take $n > 1$, then in order that torque may increase, n must be smaller than U - E/E, which never occurs when $E > U/2$. For values of E smaller than t is, torque increases with the field as long as n remains smaller than U - E/E. The resulting speed variations follow, of course, the same law as the torque.

Next as to permanent changes. If we suppose that the resisting torque due to load remains constant, then the driving torque must also be fairly constant at all speeds, or we may assume:

$$FI = K,$$

K being a constant. Now when E increases I must decrease, and, therefore, from the above equation it is evident that F and E always n increase simultaneously, so that all we have to determine is how N varies with E, N being the number of revolutions per second of the speed. Since torque is constant:

$$EI/N = k.$$

and substituting value of I,

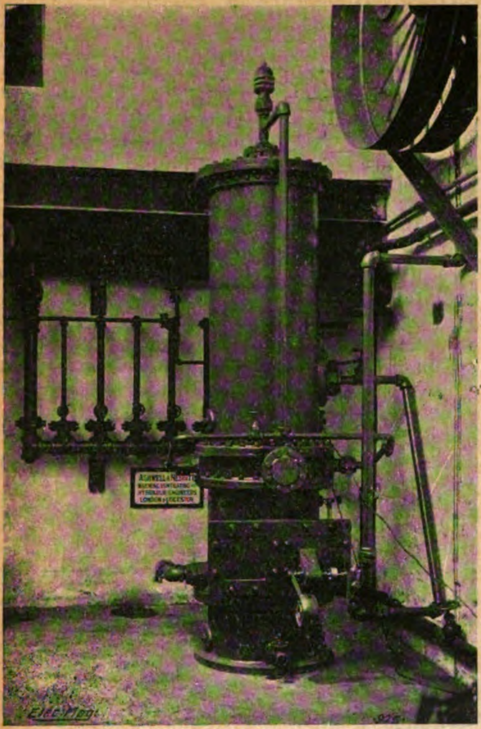
$$E(U - E)\ k_2 N$$

k_1 and k_2 being constants. From this we see that N reaches a maximum when E = U/2. For values of E smaller than this, E and N, and consequently F increases simultaneously, *i.e.*, increase of exciting current produces increase of speed. For values of E larger than U/2, a condition which is most usual in practice, N decreases while E increases, and therefore increase of exciting current produces decrease in speed.

Curves may be drawn illustrating the variations in speed produced by field-flux variations, with a given armature resistance. These curves will show that when, as is most usually the case, the armature resistance is very small, the field must be altered very considerably to produce important changes in speed, and the range of speed obtainable is still further limited by the fact that increase of exciting current does not, as a rule, produce a proportional increase in flux. Another restrictive condition is that a reduction of say 20 per cent. in the value of the field brings a corresponding increase of 20 per cent. in that of the armature current, which must be kept within well-defined limits both to avoid overheating and commutating difficulties. From this latter point of view it would be preferable to vary the flux as in M. Couffinhel's process, by widening the air-gap. One way of solving the problem is to insert two rheostats, one in the field and the other in the armature circuit, but the simultaneous working of these rheostats should be accurately predetermined, as the sense in which one acts depends on the value of the resistance of the other.

"NUCONOMISING" FOR CENTRAL STATIONS.

EVERY central station engineer knows what he does with his water condensation, though he may be the only man on the spot who does know. Visitors inspecting works are not always permitted to see where the innumerable steam traps discharge their



NUCONOMISER CONNECTED UP FOR WORKING CONDITIONS.

water, unless the engineer has something special to be proud of. This is generally not the case; in fact, he will curse the inquirer and his query when asked point blank what use he makes of his steam "by-products." The situation is an uncomfortable one to say the least of it, but judging by recent investigations into this arid region of steam-plant operation, there is some hope of fertilising what is otherwise a desert waste. To this end Messrs. Ashwell and Nesbit, Leicester, have experimented, and after successfully applying their apparatus, appropriately termed the "Nuconomiser," to large steam heating systems, they have introduced a modified form suitable for central station purposes. Briefly, their method admits of the recovery of all water of condensation, in a completely closed piping system without loss of heat units or pressure; the water being collected in a manifold header, which leads it into the Nuconomiser. This latter as will be seen from the illustration comprises a large upper chamber, a smaller central chamber, and a base. The upper chamber contains a nest of pipes in the centre and baffle plates at the outside. The exhaust steam line is coupled to this chamber, entering at one side and leaving at the other to pass on to the condenser. Into the central chamber the steam from the manifold header, that is from all the steam traps, discharges, while the hot water from the same source is piped by a bend into the base, which forms the hot well. In the central chamber a sparger is fitted which condenses the steam and both the spraying and condensed water fall into the well. A float is fitted in the well, controlling a valve which admits make up feed water as required. The sparging water is also furnished from the feed. By an arrangement of the condenser receiver and its piping, water can be delivered into the boilers at practically boiling-point, a circumstance which secures marked economies without, as it will be seen, any additional expense. In the case of steam electric power-plants a condenser is required as usual. We understand that at the Brighton Hotel Metropole, where the system has been operating for over twelve months, a yearly saving of 20 per cent. in the coal bill has resulted. Stations operating feed water heaters and other devices to heat the feed will, doubtless, be interested in this device, which seems to be a happy combination of exhaust heater, hot well, and condenser. We understand that Messrs. Ashwell and Nesbit are prepared to furnish particulars of larger designs than that illustrated, to deal with greater quantities of steam and water. We may say before concluding, that the apparatus is in addition an admirable grease separator.

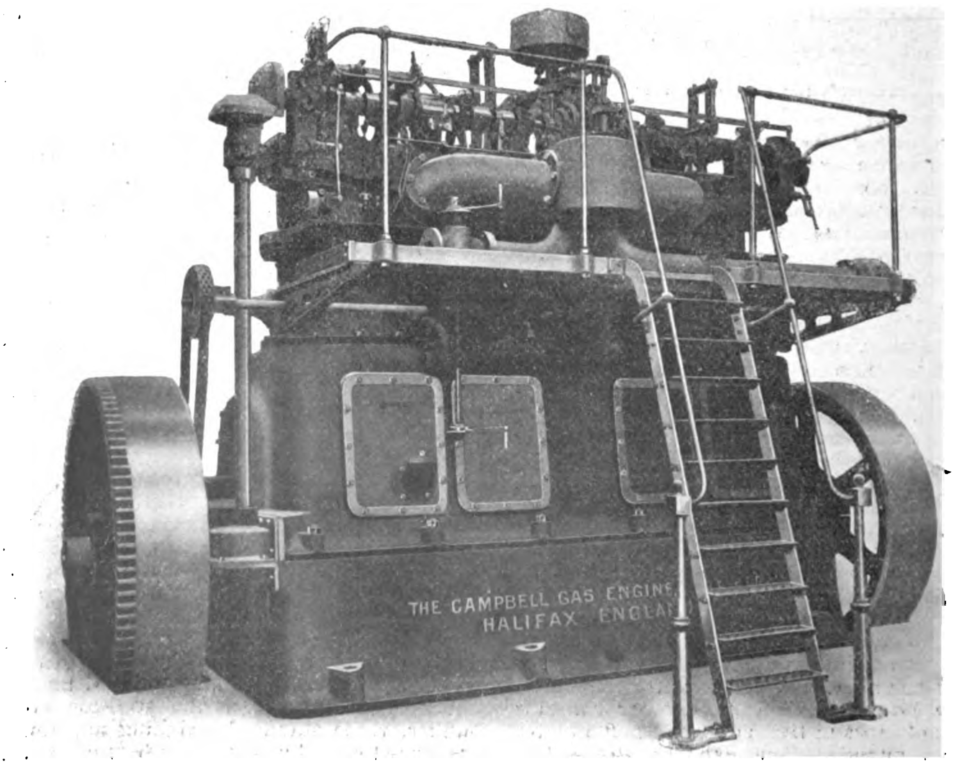
COAL-HANDLING PLANT AT MELBOURNE ELECTRICITY WORKS.

IT is now becoming customary for all coal required on an electric light station to be handled entirely by machinery. The stoker's shovel thus passes out of existence. We have referred in previous issues to the value of coal-handling plant, and the economical influence it exerts on central station costs. The majority of large British stations are now fitted with modern apparatus of this description, and we are pleased to note that our Colonial friends agree with home practice, and not only so, but follow up their decision by placing orders in the mother country. Messrs. Graham, Morton and Co., Ltd., Leeds, have recently designed, constructed, and delivered to the Melbourne City Council Electricity Works a large coal- and ash-handling plant for the boiler house at the power station. The contract included a coal-receiving hopper, jigging screen, four-roll crusher, Graham's patent revolving filler, an 18-in. standard bucket conveyor 280 ft. long, one 500-ton steel bunker, three standard weighing machines, one ash-storage bunker, of 12 tons capacity, and the necessary shoots for delivering into carts. The entire plant is electrically driven by three motors suitably geared. Space

will not permit us to refer in detail to the plant, but from an account furnished by the company it is a fine specimen of its kind. The weighing machines are interesting, especially as this device is only just becoming generally adopted. In the present case the three machines are furnished with delivery shoots having the combined capacity of 15 cwts. per operation. They are provided with suitable gear for automatically recording and accurately weighing every load, indicating the total on a dial.

GAS-ENGINES FOR CENTRAL STATIONS.

At a meeting of the Leeds local section of the I.E.E. on November 17, Mr. Hugh Campbell presented a paper on the above subject. Mr. Campbell reviews the experiences of engineers with gas-plant in central stations and gives a number of instructive tables comprising the working costs of gas- and steam-plant. We must refer our readers to the complete paper for these, meanwhile we publish an illustration of an interesting vertical type of gas-engine which Mr. Campbell's company is making, and a number of which are running in Guernsey and at Hebden Bridge. A description of this is taken from the paper: "The gas-engines of St. Sampson's station, Guernsey, consist of two four-cylinder vertical engines of the enclosed type (*see* Fig.) working on the 'Otto' cycle, each developing 300 b.h.p. on producer gas, the normal speed of each being 250 revs. per min. The engine cylinders are 17 in. diameter by 17 in. stroke, the pistons being direct coupled to four-throw crankshaft running in three bearings. The sequence of the explosions in the cylinders, commencing with the cylinder on the left hand, is Nos. 1, 2, 4, and 3. Splash lubrication is adopted for oiling the crankshaft, connecting-rods, pistons, and cylinders, and this has been found to be very effective and satisfactory. The whole of the valve-gearing is mounted on the top of the cylinders, the cam shaft being driven by screw-gearing and bevel wheels from the crankshaft. The exhaust valves and exhaust valve box are of special construction, in that they are both independently water-cooled. The method of governing adopted is that known as the throttle system, which is carried out exactly on the lines of the steam throttle."



300-B.H.P. FOUR-CYLINDER VERTICAL PRODUCER GAS-ENGINE INSTALLED AT GUERNSEY AND HEBDEN BRIDGE.

Electrical artisans should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles on subjects of importance to themselves.

*Multiple Voltage Control of Motors.**

To give as briefly as possible an outline of the multiple-voltage system, let us begin with the power-plant and discuss the characteristic features step by step until we reach the motors and their individual application. The generating plant for multiple-voltage equipment is, in no way. different from that of an ordinary two-wire system. It may consist of one generator alone, or of more than one operated in parallel and arranged in sizes most suitable for the load to be carried. The generator ordinarily supplies the highest voltage of the system, though where the multiple-voltage system is added to an existing 110-volt plant, the generator voltage is used for one of the intermediate sides, and the maximum voltage is obtained by taking current from the outside wires.

Where the generator supplies the highest voltage, it is called the primary voltage. It is subdivided by a balancing set, in size but a fraction as large as the generators, yet it serves to feed into any over-loaded side power drawn from the more lightly loaded sides. This action accomplishes what the name implies, a balancing of the system. The wiring for a multiple-voltage equipment of a factory or machine shop consists of adding to the ordinary two-wire distribution, two additional wires, which are kept at intermediate potentials by connection to the balancing set. This balancing set is automatic in action, requires little attention, and is most convenient in maintaining a proper distribution of power among the various feeders. It operates in exactly the same manner as the two-unit balancing set in a three-wire system, which is well known on account of its general use in connection with lighting circuits. At the motors is placed a controller, which is attached in the most convenient position, and is operated by a single handle that controls both forward and backward motions. The controllers by quick jumps entirely disconnect the armature of the motor from one pair of conductors and connect it to another pair before the motor has a chance to slow down. The result is that the changes in the speed of the motor are comparatively smooth.

The Bullock Electric Manufacturing Company introduces intermediate steps between the different voltages by the use of resistance in series with the shunt field. This method gives a wider range of speeds. The Crocker-Wheeler Company employs the same principle in some cases, and in others makes use of an armature resistance. This resistance is placed between the voltage speeds, and serves to cushion the passage from speed to speed, thus preventing strains on the motor and sparking at the commutator. As has been stated, the system of wiring is that of four wires, between which are maintained three different voltages. Some of the motors in a shop equipment do not make use of the multiple voltages and are permanently connected to the outside wires. These motors are operated in no different manner from those in the ordinary two-wire system. An ordinary machine tool operating upon several different kinds of metal will require a variety of speeds to cut each metal with the most economy. A multiple-voltage system accomplishes this very thing, since it permits a number of speeds without a waste of current through external resistance. The various speeds are obtained easily and quickly by a short movement of the controller handle, and the range they cover is amply sufficient for any possible work which the tool may be called upon to perform. These speeds

* *Power.*

are obtained by placing the motor between wires of different voltages.

The balancing set maintains the pressure constant on the various lines and feeds power drawn from the lightly loaded sides into any over-loaded side, as already stated. This action is automatic and ensures a constant speed of the motors, regardless of the load, which is not the case where a large amount of resistance is used to reduce the voltage at the motor terminals. The output of machine tools by this system is greatly increased over that of a belt drive, for it gives the operator instantaneous control of his machine over any range of speeds that may be required. He can start or stop without delay, and by turning a convenient handle he can slow down or speed up to the rate best adapted to the work he is doing. His machine is not lined up with a shaft, but is placed where it is most convenient to handle the work and the light is best. These things being true, it is not hard to see that with this system which is adapted to existing shops, a machinist drives his tool at the maximum speed possible. Brackets readily attached to machines are used to mount motors on, and the controllers are located where most convenient for the operator. The supply lines can be run in conduits beneath the flooring and tapped at the nearest point for each separate machine.

The generator, switchboard, and balancing set can all be located in the power house, entirely separate from the shop itself. The work of installation presents no difficulty, and the great saving in cost of operation of a shop so driven will more than repay a manufacturer for the first expense of such a system.

Taking up the details in connection with the actual application of the motors to machine tools, it may be stated that motors for machine shops can generally be divided into four classes, because of their different characteristics and the manner in which those characteristics affect the system and work.

First—Fixed-speed motors, such as drive groups of small tools by shafting.

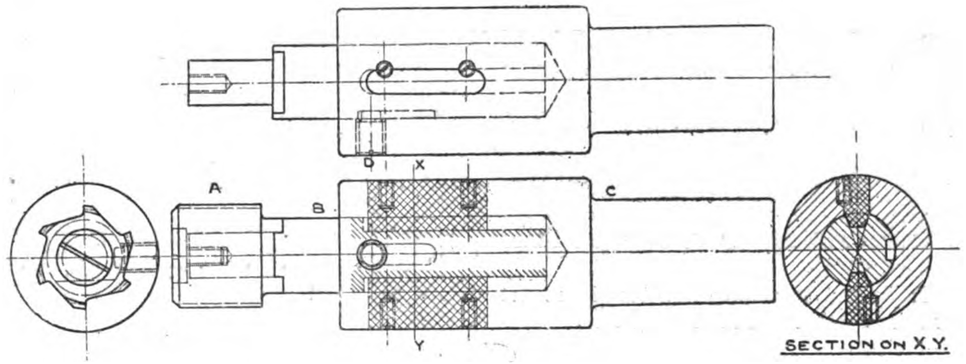
Secondly—Controllable-speed motors of the series-wound kind, such as are used on cranes. While they are to run at varying speeds, these speeds are not required to be constant. For this reason, and on account of the fact that their demands for current are intermittent and at times excessive, and would disturb the voltage of the intermediate wires, they are connected to the main or outside wires only and operated by a rheostatic controller.

Motors of the third and fourth classes are controllable, constant or steady-speed machines, and constitute the larger part of a machine-shop plant. It is these which are used for the driving of individual tools. They are alike in being connected to all four wires of the system and subject to speed-control by voltage. They differ in the manner in which power is demanded of them by the tools they drive. The third class is formed of motors driving pressure blowers, pumps, punch presses, rotary and reciprocating planers, bending rolls, cold saws, &c., in which the characteristic of the power demanded is constant torque at all speeds, or, differently expressed, those in which the horse-power diminishes as the speed diminishes. The fourth class comprises the remaining motors in the shop, and usually forms the most important group of the equipment. They operate lathes, boring mills, large drill presses, shapers and slotters of certain kinds, and, as a rule, milling machines. The distinctive demand of these tools, of which boring mills are typical is approximately constant horse-power over a wide range of speeds, or, otherwise expressed, a torque which increases as the speed diminishes. On this account motors of this class must be of much greater rated power than the actual power the tools demand, or they must be connected through the intermediary of some mechanical device, like a pair of cone pulleys or a nest of gears, by which the torque may be increased as the rotative speed of the tool diminishes.

The cost of multiple-voltage equipment over constant-speed equipment is very little, and, in some cases, nothing. Its efficiency is the highest possible, since there are practically no losses except those in the motors themselves. It has even been found that it pays to put multiple-voltage controllers on such tools as punch presses, to accommodate cases where tripping the tool at every revolution is a little too frequent and the operator is compelled to trip at each alternate revolution, which is too infrequent.

SLIDING TAP HOLDER.

THE sketch herewith shows a sliding tap holder, made for use in a capstan lathe. Its principal feature is that it is so arranged that the tap has a free feed. In holders where the tap is fixed, if the operator of the machine does not feed properly the tap pulls the capstan slide along and an imperfect thread is the result, besides often resulting in broken taps. With the holder shown herewith the operator brings the tap up to the work and applies sufficient pressure to start the tap. Then the pressure is relaxed and all the operator has to do is to gently follow up, leaving the tap to feed itself. By these means a perfect thread is obtained. In the case of a fixed tap it is not so easy as one would think to tell whether one is feeding correctly. When



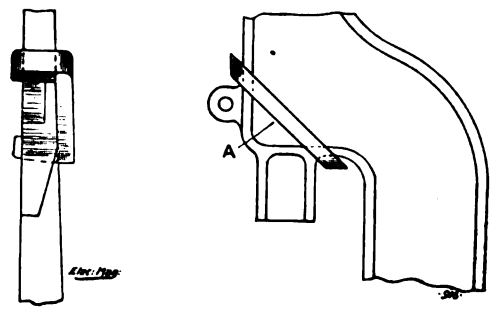
Sliding Tap Holder.

the required depth has been tapped the machine is reversed, so withdrawing the tap. For small work it is usual to use a self-releasing holder. A is the tap, the front being recessed out to receive the head of the small screw, which prevents it from coming off, and the back end of the tap has a slot milled across it, to engage with the tenon on the tool steel sliding holder (B), this, of course, is to prevent the tap from turning round. The mild steel holder (C) has two slots machined through from the periphery into the bore, and into each of these slots a hardened tool steel key is driven fitting into the keyways in the sliding holder; they are prevented from coming out by a small grub screw half in the holder and half in the key. As will be noticed, these keys and keyways are radial so that the pressure (and there is a considerable amount of pressure set up while tapping with a large tap) is taken up on flat faces instead of on corners, as would be the case if the keys and keyways were of the ordinary rectangular type, and if sufficient freedom had been allowed to ensure a free sliding action. The screw (D) the point of which fits into a groove, is to prevent the sliding holder from coming right out.

J. C. H.

BRACING A STEAM-HAMMER FRAME.

Whilst forging some large motor pinions with a 10-cwt. steam hammer, some time ago, a crack developed in one of the standards as shown at A in the sketches instead of fitting the usual cast-iron plate and fit bolts, the leading smith got a 2-in. square bar of steel and forged it to the required shape as shown, the cooling



Bracing a Steam-Hammer Frame.

contracted the bar and braced the frame up; although being in use for several months on heavy jobs since it shows no signs of further fracture.—W.D.

Important Notice.

TO ELECTRIC LIGHT AND POWER WIREMEN.

This section will be expanded in the coming year to include in its purview the interests of wiremen. Matter culled from electrical journals or subjects relating to wiring both for light and power will be concisely treated and served up for ready assimilation.

Wiremen are supplied with the Magazine on special terms.

WRITE US FOR DETAILS.

Trade and Commerce Articles of the month are classified under the World's Electrical Literature Section at end of Magazine.

The Commercial Instinct.

By W. NOBLE TWELVETREES, A.M.I.Mech.E., A.M.I.E.E.

ALTHOUGH not intended as a compliment, the saying which characterised our countrymen of a former day as a nation of shopkeepers, was really a tribute to the commercial supremacy of this country, and to the business capacity of its inhabitants. Prosperity in the past has tended, in some measure, to remove the necessity for strenuous effort, and the general increase of wealth has greatly increased the number of the leisured classes. Still, for a preponderating proportion of the nation the necessity for never-ending industrial and commercial activity has never been relaxed, and, at the present time, it is more evident than ever, owing to the rise and development of younger industrial nations. The virtual closing of foreign markets to our exporters, and the advent of foreign competition in the home market, have nerved traders and manufacturers to fresh efforts, and have induced philosophers, scientists, politicians, and lawyers with no practical knowledge of industrial pursuits, to offer much gratuitous advice to business men upon the conduct of their affairs. It has been suggested, in effect, that technical education is a sort of universal panacea for the ills from which manufacturers suffer. But we cannot believe that the promulgation of scientific knowledge would reduce adverse customs duties, turn the wicked "dumper" from his wickedness, or induce trade unions to advocate common-sense views. If the self-constituted advisers of the commercial classes would turn their efforts to the removal of political and economic obstacles in the way of industrial progress, they would do good service and might surely leave manufacturers, and especially manufacturing engineers, to adopt such measures of internal reform as may be most suitable and necessary. A mental survey of industrial engineering throughout the country is sufficient to show that technical ability is by no means lacking among the principals or general managers, works managers, staffs, and mechanics of manufactories and workshops. The necessary intellectual equipment of each class is by no means alike. Mechanics need but a limited knowledge of science, especially in this day of automatic and semi-automatic tools; draughtsmen and foremen want adequate training of special character; works managers require thorough training combined with professional and business experience, and in principals and general managers the commercial instinct should be more strongly developed than anything else. With such a graduation of knowledge and experience, a commercial undertaking is well equipped with the qualifications necessary for success.

The development of the great electrical industries of Great Britain affords a striking proof that these qualifications are fully exemplified by all grades from that of the chief organiser down to the rank and file. Electrical machinery has been brought very rapidly to its present pitch of efficiency by the direct application of scientific knowledge to questions of design and manufacture, a course that has only been evidenced during comparatively recent years in connection with mechanical engineering. The result is that works devoted to the manufacture of electrical machinery and appliances of all kinds are designed upon the most approved principles, equipped with the most modern machinery, and organised on the most efficient systems. Consequently they are able to turn out products that cannot be surpassed by makers in any country of the world. So far as concerns commercial organisation, the manufacturing electricians of the United Kingdom have little to learn from any of their rivals, and we once more express the firm conviction that, given fair play, they will continue to maintain their position against all competitors.

South African Electrical Notes.

Water-Power.—A hydro-electric power scheme has been projected for the utilisation of the water-power available at the Umtala Falls, which have a height of 71 ft., and will supply 20 cubic ft. per second. Two three-phase generators are to be erected at the power station, and current will be transmitted at 5,000 volts to a sub-station in the town of Umtala, and also to the waterworks for pumping. It is expected that 2,000 eight-c.p. lamps, including 200 public lamps, will be required for lighting.

Aliwal North Lighting System.—Various firms in England have supplied the plant and material for the Aliwal North Electric lighting scheme, which includes two 45-kw. dynamos, two 5-kw. boosters, and a balancer from the Industrial Engineering Company, a Hart storage battery of 300 ampere-hours capacity, a Crompton switchboard, British Insulated and Helsby armoured cables, and a Carrick and Ritchie travelling crane. The New British Engineering Company are supplying Nernst lamps for public lighting, Messrs. Chamberlain and Hookham the meters, and Messrs. Baxter and Caunter the house-wiring material. The generators are to be driven by turbines which will be operated by water from the Orange River. It has been decided to adopt the three-wire continuous-current system, with a pressure of 460 volts between the outers, and the voltages at consumers' terminals will be 230 for lighting and 460 for power.

Prospective Business.—Owing to the failure of the concessionaire to carry out the terms of his concession for the electric lighting of Queenstown, the Town Council will shortly invite tenders for electric or gas lighting for a period of fifteen years. It is proposed to extend the Kroonstad electricity works, which are now being equipped in accordance with the recommendations of the consulting engineer to the Council, for the supply of current for tramways and power for pumping water.

New Bills.—Mr. C. F. Parr, of 4 Bartholomew Lane, has applied to the Durban authorities for permission to introduce a Bill into the next session of Parliament, which will give him power to construct, lay down, and work a tramway connecting—on the south bank of the River Umgeni—with the tramways of the Durban corporation, thence across the bridge to be erected over the River Umgeni, and along the Government and private roads to Prospect Hall. This Bill will also apply for authority to supply electric light or power to residents in the districts concerned, and to acquire all lands necessary for the construction of the tramway.

The Municipality of East London have published the details of a proposed Bill, which will enable them to borrow the sum of £350,000 for municipal improvements, of which £4,575 will be expended on tramway extensions in St. George's Road, and at North End, £1,500 on electric light extension in Quigney, and £1,500 on electrical undertakings in Arcadia.

COTTON MILLS AND ELECTRIC DRIVING.

MESSRS. MATHER AND PLATT, LTD., of Salford Iron Works, Manchester, have recently settled an important contract for the plant required for the electric driving of two cotton mills in Spain. The well-known spinning and weaving mills with adjoining dye and hosiery works at Malaga in Andalusia belong to the Marquess of Larios—who was a pioneer in starting Spanish manufactures—and are the largest in the country, employing about 5,000 hands. Arrangements have lately been made by the Marquess for obtaining a supply of electric power from the Chorro Power Co., which has established a generating station in the celebrated Chorro gorge, some fifty miles north of Malaga. The power is transmitted by three phase-current at 25,000 volts to a sub-station in Malaga, where this pressure is reduced to 2,500 volts, part of the energy being supplied to the Malaga Electric Lighting Station.

The contract which has been secured by Messrs. Mather and Platt, Ltd., includes the underground cables from the Malaga sub-station to the two mills, "La Aurora" and "La Industria," distant about half a mile. A secondary receiving station is to be placed at each mill containing three-phase transformers for reducing the pressure from 2,500 to 400 volts for supplying the three-phase motors, which will be employed universally throughout the mills, the steam-plant being entirely discarded. There will be seventy-two motors, varying in power from 3 h.p. to 150 h.p., and aggregating 2,500 h.p. The Larios Company anticipate that by the use of electricity in place of steam they will save considerably more than 20 per cent. of the yearly cost of power. It is interesting to note that there was very keen competition for the contract by the leading Austrian, German and Swiss firms, and it is highly satisfactory to find that in neutral territory a British firm can secure such a contract in open competition, especially for polyphase plant, to which it has been generally assumed that British makers have devoted less attention than their continental competitors.

GENERAL TRADE NOTES.

An Admiralty Contract.

THE Lords Commissioners of the Admiralty accepted the tender of Meldrum Bros., Ltd., Timperley and London, for one four-grate destructor with Lancashire boiler 30 ft. by 8 ft. for 200 lbs. working pressure, in connection with the extensive Electric Light and Power scheme at Chatham Dockyard. Consulting engineers Messrs. Preece and Cardew.

Twickenham Urban District Council.

A LOCAL Government Board inquiry was recently held concerning the Council's application for sanction to borrow the sum of £40,000 for the provision of new Sewage and Refuse Destructor Works. Inspector, E. A. Sandford Fawcett, M.I.C.E. Destructor contract placed with Meldrum Bros., Ltd., Timperley and London, for two two-grate regenerative destructors, two Lancashire boilers and one Babcock and Wilcox boiler.

Exports of Telegraph Cable.

THE returns for the month of October last show no improvement in the export trade of this country in telegraph cables and apparatus. The total value of the goods exported amounted to only £69,186, bringing up the total for the first ten months of the year to £696,708, this being a decrease of £922,920 on the value of the goods exported for the corresponding period of last year, and of £1,961,706 on the ten months ending with October 1902.

New Electric Plants in Canada.

AN electric plant is now being installed by the Quebec Electric Company at St. Anne and Seven Falls. The technical work of the engineers employed by the company is finished, the plans have been approved, and all necessary arrangements have been completed. The work of constructing the dams and the foundation work in connection with the power houses at each of the falls, will be commenced as soon as possible. Water will be obtained from Seven Falls at 374 ft., the two falls developing between 22,000 and 25,000 h.p. at low water.

Electric Lighting in Australia.

IN consequence of difficulties with the Sydney Gas Company, the municipal council of Glebe a waterside suburb of Sydney, have decided to instal a combined dust destructor and electric power-plant for street lighting. The scheme will be prepared by Mr. J. R. Woodruffe Gardam, M.I.E.E., with whom is associated Mr. J. E. Dodds, and tenders will be invited as soon as the necessary particulars are ready. It is announced that owing to the action of the Gas Company several other suburban councils in the neighbourhood of Sydney are considering the advisability of establishing electric lighting systems.

Large Contracts for the British Thomson-Houston Company.

THE British Thomson-Houston Company, Ltd., which is controlled by the General Electric Company, Schenectady, N.Y., have secured one of the largest contracts for electrical equipment ever obtained by American interests abroad. The value of the contract is about £1,400,000 and includes the supply of the motor equipment for the extensive underground and surface electric traction system now being constructed in and around London by the London Underground Railways. The lines to be electrified have a total length of about 140 miles and 480 cars will be equipped with motors aggregating 500 h.p. per car.

The New Icelandic Cable.

NEGOTIATIONS in connection with the proposed cable to Iceland have now been finally completed. The work, which it is estimated will cost about 2,000 000 kronen, is to be carried out by the Great Northern Telegraph Co. of Copenhagen. Th company will receive a Government subsidy of 89,000 kronen per annum for a period of twenty years commencing from the opening of the line, and it is also intended to establish a landline from Reykiavik to the east coast of Iceland, where the cable from the Faroe Islands will terminate at a cost of 300,000 kronen. The new cable will commence at Lerwick in the Shetland Islands, which are in telegraphic communication with Scotland, to the Faroe Islands and thence to Iceland, and it is anticipated that the line will be in working order in the year 1906. A cable station will be erected at Thorshavn in the Faroe Islands.

Electrical Plant for Collieries.

AMONG other recent notable orders, Messrs. Ernest Scott and Mountain of Newcastle, have secured the following: For the Bedminster Coal Co., Bristol, one 300-h.p. steam unit and complete motor equipment for drivng underground haulage, pumps, &c., the plant in this case will be driven by polyphase machinery; for the Whitwick Colliery, Leicester, one three-throw horizontal pump with motor, cables, &c., the pump delivering thirty to forty gallons per minute, against the head of 500 ft.; for the Wallsend and Hebburn Coal Co., a one three-throw electrically driven pump of 100 h.p. for delivering 1,000 gallons per minute against a head of 180 ft.; for a leading Indian colliery, one portable three-throw pump and motor mounted on a trolley head plate for working against a 1,200 ft. head; for Messrs. North's Navigation Colleries, Ltd., an extension to plant supplied some time back, consisting of a 450-h.p. steam unit, and two main and tail 100-h.p. haulage gears, electrically driven.

Amalgamation of Californian Electrical Undertakings.

A SCHEME has lately been projected for the consolidation of all the lighting and power-plants of Santa Cruz and Watsonville, with a view to merging them into a company, which will include all the lighting and power companies and some street railways of San Jose. The first step towards the accomplishment of this undertaking was made some time ago, when the electric street railways of Santa Cruz were consolidated. It is stated that the absorbing company will establish electric railway connection between San Jose and Santa Cruz, and

at some future time will extend the present lines from Santa Cruz to Monterey. When these connections have been made, and when the San Mateo electric line to San Jose has been extended—a project which is stated to be under consideration by the United Railroads of San Francisco—a through electric line will be established between the bays of San Francisco and Monterey.

An Australian Opinion of Telephones in America.

ACCORDING to the *Sydney Daily Telegraph*, Mr. Hesketh, who represented the Commonwealth at the St. Louis Exhibition, "is astonished to find that although telephone services in America are no cheaper than those in Australia the use made of them is much greater. In Australia from 2 per cent. to 3 per cent. of the population utilise the telephone, as compared with 12 to 13 per cent. in the United States." In a letter to the central postal administration, Mr. Hesketh remarks that the way in which American telephone companies cater for public business is remarkable, adding that "Every few yards one comes to a slot telephone, where for a modest nickel you may talk to any one on the network." It is believed that there is a great future for public slot telephones on the American plan in Australia, and we understand that the postal authorities have decided upon the installation of a system of electrical alarms between the banks, business places, and police stations.

Egyptian Notes.

IT is gratfying to note that some of the largest British engineering firms have formed an amalgamation in Alexandria and Cairo, under the direction of one general representative. The firms are as follows: Messrs. Dick, Kerr, and Co., Ltd., Callender's Cable and Electrical Construction Co., Ltd., Messrs. Babcock and Wilcox, Ltd., Messrs. Gwynnes, Ltd., and Messrs. J. Gibbs and Co. The combination bears the name of the "British Engineering Co. of Egypt, Ltd.," and consisting of firms of the first rank, the centralisation of their different interests and operations should lead to a rapid expansion of business with the United Kingdom. The imports of electrical, telegraphic, and telephonic apparatus into Egypt during the years 1901, 1902, and 1903, amounted to about £42,000, £55,200, and £67,780, respectively, and of these the United Kingdom sent the greater part. We may again repeat the advice that manufacturers who wish to do business with Egyptians will do well to establish direct representation in Cairo and in Alexandria.

Comparative Cost of Water-Power.

IT is stated in the *Journal of the Franklin Institute* that the cost of water-power development in France varies from £4 6*s*. per h.p. to £30 per h.p. ,depending on the head to be dealt with, h.p. being calculated at the turbine shaft. The lowest expenditure in that country is upon a fall of 460 ft. in Haute-Savoie. At Geneva, for the first group of 800-h.p. turbines erected, and for the river works then completed, the capital cost amounted to £60 per effective h.p. The groups of turbines subsequently erected cost only £19 per h.p., making the average cost of the completed works about £27 per h.p. At the chlorate works at Valorbe, the capital expenditure upon the development of 3,000 h.p. amounted to only £3 4*s*. per h.p. At Niagara the rates charged to ordinary consumers by the Cataract Power and Condut Co. vary from 1*d*. per unit up to 1,000 units per month down to 0.32*d*. per unit for 80,000 to 200,000 units per month. The cost of energy for power purposes from water-power stations in France and Switzerland varies from 1.05*d*. per unit for small powers, to 0.62*d*. per unit for large powers.

British Trade Advance in Siam.

ACCORDING to a Consular Report published last month, the proportions of the imports into Bangkok from various countries are as follows:

Country.	Proportion. 1902. Per cent.	Proportion. 1903. Per cent.
United Kingdom	33.09	43.36
Singapore	19.34	32.11
Germany	34.44	12.11
China	2.2	3.43
Hong Kong and Burmah	2.06	3.25
United States	4.4	3.04
Other countries	4.47	2.70
Total	100	100

From the foregoing figures it will be noticed that the United Kingdom has regained the lead held by Germany for the last two years. In 1902 the German imports mainly consisted of material supplied to the Royal Railway Department, and the outfit of a newly erected German rice mill. The items in which imports from the United Kingdom exceeded those from any other country during 1903 were: Iron sheets and plates, wire, wire rope and cables, wrought iron and manufactures thereof, and machinery. Of milling machinery 80 per cent. and of other machinery 42 per cent. came from the United Kingdom.

A New Trolley Wire.

ONE of the many troubles electrical tramway engineers have to contend with is the depreciation of overhead wires, especially in manufacturing districts and in close proximity to chemical works. This difficulty is overcome by a new combination wire having a steel core with a copper cover, these two metals by a new process of manufacture are electrically combined giving the strength of steel wire with a copper or bronze surface. They afford the same result as pure copper or bronze wires, viz., after a short period they are coated with hydrocarbonate of copper, and so adherent to the metal that their life is almost unlimited.

These mixed metal wires are now being made from 26 ins. W.G. up to any thickness, and the copper cover of same can be varied according to requirements. These wires can also be woven into cables for span or trolley wires and is also manufactured for high conductibility purposes. We understand already several of our Tramway Corporations are using these wires for different purposes, and we should say there is a vast field open for such a wire, as we are assured it is practically indestructible and will take the place of galvanised wire to a very

great extent. We understand that this wire is being put on the English market by Mr. J. Bennett von der Heyde, Manchester.

Electrical Apparatus for Russia.

During the last twenty years, researches have been made with the object of discovering a waterfall capable of furnishing sufficient power to supply St. Petersburg with electricity. Until recently a cataract in Finland has been thought to be best suited for the scheme, and it was proposed to utilise this for the working of an electric tramway. As a result of more recent researches, however, the Kiviniemi waterfall on the River Voksen, forty-six miles from St. Petersburg, with energy equivalent to 25,000 h.p. has been discovered. This waterfall is about forty-five miles nearer the metropolis than the one in Finland, and is offered for sale at a considerably smaller price. Unless the difficulties of transmitting current prove to be too great, the Kiviniemi waterfall will be purchased, and this will enable electricity to be supplied to private houses at a moderate rate, a consummation practically impossible if power had been obtained from Finland. We learn that a company has been formed which will supply electric light to the town of Kokand in the Province of Ferghana. One thousand shares of the value of £6 6*s.* 8*d.* each have been taken up. The municipality of Kokand have stipulated that 5 per cent. of the lights furnished shall be supplied free of charge to the Government and municipal buildings in the town.

Contracts Pending in Mexico.

A large amount of electrical equipment will shortly be purchased for shipment to Mexico, where it will be installed in the mining property which is to be developed on a large scale by the Braniff Mining and Smelting Company, just organised in the southern republic with a capital of £600,oco. The properties are known as the Cadereyta mines and are situated in the state of Queretaro. Power to carry on the mining operations will be derived from a waterfall on the properties. A large concentrating plant is also to be erected at Macoui, with an initial capacity of 200 tons a day, ultimately to be increased to 500 tons. Considerable cableway work will also be executed. The district is expected to become one of the great mining camps of Mexico, and it will result in the installation of large quantities of electrical machinery in the near future.

The Federal District Railway Company of Mexico City has decided upon the electrification of several sections of its tramway system. The construction of an extensive hydraulic plant to supply the cities of Parral and Jimenez with power for lighting and other purposes is contemplated by Messrs. Ramon F. Lujian and Julio Muller, who are large owners of land in the State of Chihuahua, where a good-sized waterfall is available.

Tenders Invited.

Municipal authorities of Guirgin, Roumania: Electric Lighting of town, January 28, 1905.

Shanghai: Construction and working of twenty-four miles of electric tramways on trolley system, March 31, 1905.

Johannesburg Municipal Council: Transformers, pillars, and switch gear (to specification of Messrs. Mordey and Dawbarn, 82 Victoria Street, S.W.), December 27, 1904. Two 35-ton electric overhead travelling cranes (to specification of Messrs. Mordey and Dawbarn), December 27, 1904.

Deputy Postmaster-General (Sydney) for Australian Commonwealth: Supply and delivery of telegraph, telephone, and electric light materials, December 28, 1904.

Tenders Accepted.

Middlesex County Council: Railway No. 3.—Station Road, Wood Green, £17,266; Clift Ford. Railway No. 6.—High Street, Harlesden, £36,337 16*s.* 9*d.*; Dick, Kerr, and Co. Light railway, £40,905 14*s.* 6*d.*; Dick, Kerr, and Co. Telephones, electric bells, &c., at Napsbury Asylum, £2,477; Cox-Walkers.

Barking District Council: Road widening and trackwork, £11,200; D. T. Jackson. Electrical Equipment, £694 15*s.* 8*d.*; Dick, Kerr, and Co.

Falkirk and District Tramways Co.: Permanent way construction of tramways, electrical equipment, &c., £81,000; Bruce Peebles and Co.

Lincoln Corporation: Equipment on G.B. surface contact system, £24,000; W. Griffiths and Co. (permanent way work), G.B. Surface Contact Co. (electrical equipment).

Scottish Central Electric Co.: Engine house equipment for power station, £15,500; Bruce Peebles and Co.

Brighton Town Council: Altering and extending engine-room at Southwick power station, £5,285, Erecting switchboard gallery at North Road, £820; British Westinghouse Co.

Aston Corporation: Steam generator, £1,529; General Electric Co.

Liverpooil: Power mains for electric cranes arc and incandescent lighting at Wellington, Dock; Walsall Electrical Co., Ltd.

Hammersmith Guardians: Telephones, fire-alarms, electric bells, for workhouse at Wormwood Scrubbs; Private Wire and Telephone Installation Co.

Swindon Council: Two tramcars, £1,120; Dick, Kerr, and Co.

PERSONAL PARAGRAPH.

A New Consultant.

Mr. W. B. Esson has announced his intention to start in practice as a consulting engineer and electrical expert. Mr. Esson, who must be well known to our readers, has held the post of chief engineer and manager to leading electrical engineering firms for the past twenty years, and during this time has been responsible for carrying through numerous important electric light and power schemes. He is consequently in a position to give advice based on practical experience of an exceptional order. We understand that he may be consulted on all technical and commercial matters connected with electrical undertakings. His new address is 1 Victoria Street, Westminster, S.W.

ELECTRIC FINANCE and Legislation.

Parliamentary Work.

By the ASSOCIATE EDITOR.

FROM the notices which have appeared, there will be considerable work for Parliament next session, in connection with the large number of electricity supply and traction bills which will come up for consideration. There are several applications for provisional electric lighting orders by Corporations and Urban District Councils, including Gravesend, Stratford-upon-Avon, Tewkesbury, Golborne, Haydock, Hipperholme, Little Hulton, Ravensthorpe, and others.

Among the Electric Lighting Bills are some important and debatable proposals dealing chiefly with the London and neighbouring areas. Some of these bills are to acquire powers to supply generally over areas which are already being supplied by the local authority, and are certain if proceeded with to be most keenly contested. The Bill being promoted by the Metropolitan Electric Supply Company is perhaps the most important under this section, and is to enable them to supply and distribute electrical energy for all purposes within the metropolitan boroughs of Westminster, Marylebone, St. Pancras, Holborn, Hampstead, Paddington, Kensington, Hammersmith, Chelsea, and Fulham, and in the borough of Ealing, the urban districts of Acton, Hanwell, Southall, Norwood, Greenford, Uxbridge, Hayes, Chiswick, Brentford, Heston, and Isleworth, Twickenham, Teddington, Hampton, Hampton Wick, Sunbury-on-Thames, Feltham, and Staines, and the rural districts of Uxbridge and Staines.

The Charing Cross and Strand Electricity Supply Corporation seek powers to supply electrical energy in bulk in parts of the city of Westminster, the metropolitan borough of Holborn, the City of London, and the metropolitan boroughs of Islington, Stoke Newington, Hackney, Finsbury, Shoreditch, Bethnal Green, Stepney and Poplar in the county of London, and the county borough of West Ham, also the borough of East Ham and the urban districts of Barking Town, Ilford, Romford, Wanstead, Leyton, Walthamstow, Woodford, Buckhurst Hill, Chingford and Dagenham parish, in the county of Essex, and the urban districts of Edmonton, Tottenham, Hornsey, Wood Green and Southgate in the county of Middlesex ; to enter into agreements for the supply of electrical energy.

Under the heading of "Tramway Bills" there are a considerable number of extensions proposed, but not as important as those promoted last year.

Tramway Provisional Orders are being applied for by Bradford, Liverpool, and Luton Corporations, and King's Norton and Northfield District Councils. Several other Corporations, including Croydon, Bury, Liverpool, and Nottingham are applying for special powers by clauses proposed to be inserted in Omnibus Bills.

BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY.

THE report of the directors of the British Westinghouse Electric and Manufacturing Company, Limited, which we give below is certainly not very cheerful reading for the shareholders, and supports very freely the views we have expressed with regard to these large manufacturing concerns. There is little doubt that we are now suffering to a considerable extent from over production, and we imagine the American experts connected with this company now freely appreciate the difference in the conditions under which trade is conducted in America and England.

Their report for the year ended July 31 last states that the accounts show a profit of £50,550. After providing for debenture and loan interest and for the further items set out in the profit and loss account, a balance of £2,809 remains, which the directors propose to carry forward. A considerable sum for the maintenance of the large machine tools has been charged to revenue during the year under review, and latterly patterns, drawings, &c., have been charged to revenue.

The directors, therefore, are of the opinion that the sum of £10,500 provided for depreciation is sufficient to meet requirements. The buildings have been well maintained, and, in the opinion of the directors, no special provision for depreciation thereon is at present necessary. The board has not deemed it necessary to write off any depreciation on patents in view of new ones that have been taken out. The result obtained at the close of this the first complete year of manufacturing has shown that the general expense and outlay incident to the development required in connection with the company's plant at Trafford Park has been much greater than the management anticipated. The varied and, to a large degree, novel character of the work undertaken more than a year ago required additions in equipment of any kinds, and the expense met with in forming the organisation required to execute such work has involved considerable outlay. These expenditures have, however, placed the factory in an advantageous position to execute orders in the future for large generating units. The management has been active in perfecting the company's organisation in all departments, and improvements materially curtailing manufacturing costs and diminishing selling and administration expenses have resulted. A larger amount of work is now being turned out for a smaller amount of labour than formerly, and a matter of equal importance is that the porportion of contracts executed in the works, as compared with finished material purchased from other manufacturers to fill such contracts, is increasing, while, at the same time, the margin of profit on work executed in the factory is moving upwards. While it is not possible to declare a dividend upon the preference shares, the outlook is one which encourages the directors to look forward to an improvement during the current year. The following particulars are given, covering orders received during the past three years: Orders received during the year ended July 31, 1902, £932,000; during the year ended July 31, 1903, £1,657,114; during the year ended July 31, 1904, £927,336. During the year under review business was inactive, and few large contracts were placed; but, notwithstanding the general depression, the keen competition between manufacturers at home, and the vigorous efforts of Continental firms to secure British business, the company has taken orders during the first three months of the current year aggregating £311,000, as compared with a total of £210,000 for the corresponding period of last year.

ELECTRICAL INVESTMENTS.

THE directors of Edmundson's Electricity Corporation, Limited, have decided to call in more capital. The total share capital authorised amounts to £800,000 divided into £80,000 6 per cent. cumulative preference shares of £10 each, and 80,000 ordinary shares of £10 each. Of these 70,000 preference and 70,000 ordinary have already been issued, and are fully paid up. The balance of 10,000 of both classes is now issued at the price of £5 15*s.* per share The shareholders alone are invited to subscribe, but arrangements have been entered into for guaranteeing the subscription of any ordinary shares not taken up by the shareholders. Hitherto the shareholders have always responded in ample volume to invitations for fresh capital, and in this case the assurance that no more money will be required in the form of share capital for some years at least will stimulate the applications. On the issue of the circular announcing the offer the ordinary shares of the company reacted at 5⅞ to 6⅛.

The following information regarding the progress of the Edmundson enterprise is given in the circular:

"The growth of the electric lighting and power stations in which the Corporation is interested continues to be satisfactory. This issue is made to provide for extensions of plant necessitated by this growth, as well as for the erection and equipment of central stations for Ramsgate and Inverness which are now being proceeded with, and which (as far as the directors can see) will complete the number of undertakings for which they consider that this Corporation should find capital. The directors feel, therefore, justified in stating that they consider no further issue of share capital will be required, at any rate for some years.

"The profits of the Corporation for the past four years have been as follows:

Year ended March 31.	1901.	1902.	1903.	1904.
Interest and dividends on investments . .	£11,108	£12,756	£15,845	£18,914
Trading profits, &c. .	16,529	22,338	41,079	44,784
Total profits . .	£27,637	£35,094	£56,924	£63,698
Interest on debenture stock and loans . .	5,096	6,333	10,05	11,026
	£22,541	£28,761	£46,869	£52,672

"During the same period dividends of 7 per cent. per annum on the ordinary shares have been regularly paid, in addition to which £70,000 has been added to the reserve fund, £15,000 has been written off goodwill and the amount of undivided profit carried forward has been increased by £9,765. A full half-year's dividend of 3*s.* per share will be paid on the preference shares on May 1, 1905. The dividend on the ordinary shares will accrue from the due dates of

the various instalments but payment in full may be made on or after allotment under discount at the rate of 3 per cent. per annum."

GENERAL FINANCE NOTES.

The Electrical Industry.

THE position of the German Electrical industry continues to remain eminently favourable, and work is plentiful. The Siemens and Halske Electrical Engineering Company is able to announce a dividend of 7 per cent. for this year, as against one of 5 per cent. last year According to the annual report of the Allgemeine-Electricitäts-Gesellschaft, the company has taken over from the General Electric Company thirty-eight German and eighty-five foreign patents. Moreover, the German company further receives from the General Electric an option on all applications on the part of the latter for patents in America, with the right to take out patents on these throughout Europe.

A German syndicate has entered upon negotiations with Mr. Edison in New York with a view to founding a company in Germany, with Mr. Edison as a director, for taking over Mr. Edison's new patent accumulators for automobiles.

German Electrical Industry.

THE following report from the Berlin correspondent of the *Times* should make all interested in the electrical industry of Great Britain think seriously over the general conditions, and the many difficulties under which and against which our industry is struggling *incers pas.* There can be little doubt that the preponderating influences of the local authorities is bad for general progress. Their undertakings are not making the strides forward that they should do owing to the want of proper business knowledge and energy of those responsible for their direction, and the power the local authorities have for checking new enterprises because such may, in their opinion, cause undesirable competition with their gas undertakings must be reduced.

The assistance rendered by our Government is of such slight value as compared to the effective aid given to the electrical manufactures by the German Government that one wonders how long we shall sit patiently watching our trade departing.

The County of Durham Electric Power Supply Company.

THE report for the half year ended June 30, 1904, states that the capital expenditure at the end of the half year amounted to £89,299 14*s.* 6*d.* 6,842 ordinary shares of £10 each have been subscribed, and upon these the sum of £66,404 has been paid up. The total revenue for the half-year ended June 30, 1904 amounted to £9,009 3*s.* 6*d.*, and the expenditure to £8,076 14*s.* After providing for interest on temporary loans, amounting to £518 1*s.* 6*d.*, and adding £261 7*s.* 1*d.* from last account, there remains a balance of £675 15*s.* 1*d.*, which the directors recommend be carried forward to the next account. On September 12, 1904, an agreement was entered into with the County of Durham Electrical Power Distribution Company, Limited, under which the latter company are to subscribe up to 4,500 ordinary shares of the company, so as to provide for the extension of the business, including the necessary outlay on the Trunk main from Gateshead to Jarrow mentioned in the last report to the shareholders.

Cape Electric Tramways, Limited.

THE report of the directors of the Cape Electric Tramways for the year ended June 30 last states that the profit and loss account shows, after providing for debenture interest and redemption of debentures, a net balance to credit of £57,080. From this sum the directors have paid to the shareholders 10 per cent. upon their capital, represented by two interim dividends of 5 per cent. each, paid on January 28 and on August 17 respectively. The reserve fund has also been credited with the sum of £8,000, making a total appropriation of £56,000, and thus leaving a balance of profit of £792 to be carried forward. The passenger and revenue returns for the Cape Town system for the twelve months under review both show a slight increase over the previous year, and the expenditure account a small decrease over the same period. This is satisfactory as indicating that, in spite of the great general depression and the financial crisis which have been felt in Cape Town during the past year, the Cape Town Tramways have maintained their position. An increase of passengers and revenue has also been experienced in Port Elizabeth; but, on the other hand, the expenditure account of that system has had to bear several very heavy charges during the past twelve months, due principally to the necessity for constructive repairs to the permanent way, to a serious increase in the coal account, and to other special items, amounting in all to about £6,000. At the commencement of the year 1904 the board appointed an independent general manager for the Post Elizabeth system —Mr. J. A. Barkley—and the directors are glad to be able to now state that the improved condition of this system and the decreasing expenditure have fully justified them in this measure and in the selection of the present manager to the post in question at Cape Town. During the year under review, the important extension of Hanover Street was opened to traffic. At Port Elizabeth the Board has sanctioned an extension on the Walmer Road to the municipal boundary, which is now being proceeded with, and on completion of the same an extension on the Cape Road, also in the direction of the municipal boundary, will be taken in hand. These two extensions are amply justified by the increase in the number of suburban residents in these districts. As regards the power house at Port Elizabeth, the additional unit referred to in last year's report has since been completed and is working in a satisfactory manner The Camps Bay Tram Line, leased from the Cape Town Consolidated Tramways and Land Company, Limited, by this company, has not hitherto proved the success that was anticipated. Owing to the utter stagnation of the building trade and general great commercial depression in the Cape Peninsula, the growth of the Camps Bay suburb

has been practically at a standstill during the last twelve months; and, consequently the leased tramline has had no chance of showing successful returns. The loss on the year's working, including the rent paid to the Consolidated Company, amounts to about £9,000.

Bullers Limited.

In presenting their annual report for the year ending July 31, 1904, the directors regret that in consequence of the depressed state of trade throughout the country reduced profit has to be recorded, but the year's work in the circumstances may be considered satisfactory. The increased development of the business has necessitated a small addition to buildings and plant to meet the requirements of existing contracts. The trading accounts, after paying directors' fees and managing directors' salaries, show a profit of £31,197 8*s.* 11*d.*, which with £833 12*s.* 5*d.* brought forward makes a total of £32,031 1*s.* 4*d.* The interest on the preference shares, £7,500, and dividends of 7½ per cent. on the ordinary shares, £11,250, have been paid, leaving a balance of £13,281 1*s.* 4*d.* The directors propose to pay a further 2½ per cent. on the ordinary shares, making 10 per cent. in all; this will require £3,750; to place £5,000 to reserve, which will then amount to £45,000, and to pay a bonus of 2½ per cent. on the ordinary shares; this will absorb £3,750; and to carry forward the balance of £781 1*s.* 4*d.*

Lichfield.

The Corporation have had under consideration the charges in connection with an application for an Electric Lighting provisional order. Owing largely to the opposition of the local Gas Company, the charges amounted to some £332. The chairman of the Gas Company, who is an Alderman of the City, thought it monstrous that the ratepayers should be called upon to pay the bill. The electric light was a failure, and many towns had abandoned their installations. We pass over the want of accuracy—it is so usual—but draw attention to the manner in which local authorities conduct their business. It is impossible to conceive anything more unbusinesslike or more conducive to failure than this illustration. The Corporation are actually endeavouring to proceed with an electrical undertaking, and supply the Chairman of the Gas Company with full details and the opportunity for raising objections and influencing by his position upon the Council the policy to be adopted. This is unfortunately by no means an isolated case. At Dudley a member of the Council, who is also a shareholder in the local Gas Company spent considerable time at the last Council meeting attacking the annual report of the Electric Lighting Committee, and endeavoured to prove that the price charged was below cost price. Corporations bring their troubles upon their own backs by entering into competition with trading companies, and it is largely due to these disadvantages that municipal undertakings so seldom succeed when the competition is with a company. Naturally one regrets the fact that private considerations should come before the public interest, but we have to deal with men and things as they are, not as we should like them.

Read This.

In your own interests *you should observe the notices in this issue relative to our* *Special Anniversary and Souvenir Number.*

Manufacturers should not fail *to read the editorial on page 551. It means* ***business*** *to them.*

New ELECTRICAL PATENTS

Selected Specifications.

By E. de PASS, F.Ch. Inst. P.A.,
78 Fleet Street, E.C.

"Electric Cranes."

(No. 23851. Dated November 3, 1903. Stothert and Pitt, Limited, and Walter Pitt, both of Bath.)

This invention relates to an arrangement by which the load is automatically held up when the current fails during the act of lifting, and is especially applicable to cranes having a "free barrel" and a mechanical brake to which it is not convenient to apply an ordinary solenoid brake.

Claims.—(1) Operating the brake by means of a weighted lever normally held out of action by a trigger, substantially as described.

(2) The combination of the bell crank lever and the lever carrying a trigger, substantially as described.

(3) Apparatus for holding up the load when the current fails and for preventing overwinding substantially as described and illustrated.

"Welding by Electricity and Apparatus therefore."

(No. 22981. Dated October 23, 1903. Johann Harmatta of Hungary.)

This invention relates to the production, by direct electric welding, of metal articles of all kinds, especially such as are made of thin sheet metal.

Claims.—(1) A method of electrically welding thin metal sheets or thin and thick sheets or bodies, wherein the said sheets are superposed and subjected to pressure at the point to be welded, the pressure being maintained during the subsequent heating of the sheets or bodies by an electric current, substantially as and for the purpose hereinbefore described.

(2) In electrically welding thin sheets and bodies, the arrangement wherein pressure is exerted upon the bodies at the points to be welded both before and during the passage of the electric current by means of oppositely placed pin electrodes controlled by a lever or the like, substantially as hereinbefore described.

(3) In electrically welding thin sheets and bodies, the arrangement wherein pressure is exerted upon the bodies, both before and during the passage of the electric current, by oppositely placed electrodes, one of which is in the form of a movable roller and the other of a fixed current conductor adapted to receive the bodies to be welded, or both of which are in the form of roller-electrodes, one or both of which is or are actuated to effect the automatic feed of the work whilst maintaining the necessary pressure, substantially as hereinbefore described.

(4) Apparatus for electrically welding thin bodies or thin and thick bodies constructed substantially as hereinbefore described and illustrated.

"Method of and Means for Starting and Braking Electro-motors."

(No. 23664. Dated October 31, 1903. Siemens Brothers and Company, Limited of London. [Communicated by Siemens and Halske Actien-Gesellschaft of Berlin.])

This invention relates to a method of automatically starting or braking electromotors by means of starting relays.

Claims. — (1) Method of automatically starting or braking electro-motors by means of starting relays consisting in so arranging the relays that the armatures thereof are only subject to the action of the main current windings when in the attracted position at the commencement of the starting or braking and are made to fall off consecutively on the occurrence of a certain decrease in the current strength so as to consecutively short circuit the several starting resistances, substantially as described.

(2) The arrangement for carrying out the method of operating referred to in the first claim wherein the armatures of the relays are mechanically held in a raised position when the starting switch is open and are only released after the main current has been

switched on substantially as and for the purpose described.

(3) The arrangement for carrying out the method of operating referred to in the first claim wherein an auxiliary relay is so arranged as to interrupt the main current circuit during the position of rest, and only to close the same after the starting resistances have been included, auxiliary windings being provided on the starting relays by means of which the armatures thereof are attracted at the commencement of the starting, which auxiliary windings are short circuited or cut out when the auxiliary relay has closed the main current circuit substantially as described.

(4) A modification of the arrangement of the relay devices referred to in the third claim wherein the auxiliary relay is dispensed with and the device employed for controlling the motor is so arranged as to cause the main current circuit to be kept in the open condition until all the starting resistances have been included, substantially as described.

(5) The arrangement for carrying out the method of operating referred to in the first claim wherein the main current windings of the starting relays are divided, into two parts one of which parts is short circuited by the falling away of the armature of the preceding relay substantially as and for the purpose described.

"Protecting Devices for Parallel Feeders used in the Distribution of Electrical Energy."

(No. 23173. Dated October 26, 1903. Leonard Wilson, of Pittsfield, United States of America.)

This invention relates to protective devices for systems of distribution, and especially for such systems as employ feeders connected in parallel both at the generating and distributing end. In such systems it is important that if one feeder becomes short-circuited a rush of current from the healthy feeders to the faulty feeders should be prevented, in order that the fuses or other protective devices may not open the circuit of all the feeders and thus produce a shut-down of the system. In Leonard Andrews' British Patent, No. 4032 of 1902, the use of discriminating choke coils is explained for the purpose of preventing excessive current. The arrangement described in this patent, though very simple in its application to two feeders, and though applicable with modifications to any number of feeders, neverthless in the latter case introduces certain complications because of the necessary difference in size in the various choke coils used.

The object of the invention is to provide means of equal simplicity for any number of feeders for preventing the rush of current in such a system.

Claims.—(1) In combination, parallel feeders and a choke coil for each feeder having a number of turns in series with the feeder and a number of turns in series with all the feeders.

(2) In combination, parallel feeders, and a choke coil for each feeder having one winding in series with the feeder and a second winding in series with all the feeders, the ratio of turns of said windings being equal to the number of parallel feeders.

(3) In combination, parallel feeders and a choke coil for each feeder having two opposing windings of, normally equal ampere turns, one of said windings being energised by the current in one feeder and the other by the sum of the currents in all the feeders.

(4) In combination parallel feeders a choke coil for each feeder having two opposing windings of equal ampere turns, one of said windings being energised by the current in one feeder and the other by the current in all the feeders, and means for restoring the balance of the remaining choke coils when one feeder is cut out.

(5) In combination parallel feeders, and a choke coil for each feeder having one winding connected between its feeder and a point common to all the choke coils and a second winding connected in series with the like windings of the other choke coils to the common point.

(6) In combination, a plurality of parallel feeders and a choke coil for each feeder having one winding energised by the current in its feeder and a second winding opposing the first and energised by the sum of the currents in all the feeders.

(7) In combination, a plurality of parallel feeders, a choke coil for each feeder having one winding energised by the current in its feeder and a second winding or normally equal ampere turns opposing the first winding and energised by the sum of the currents in all the feeders, and means for restoring the balance of the windings when one feeder is cut out.

(8) In combination parallel feeders, a choke coil for each feeder having one winding in series with its feeder and a second winding in series with all the feeders and menas for varying the relative number of turns of said windings.

"The Telephone Service."

By H. L. WEBB, M.I.E.E. London: Whittaker and Co., Paternoster Square, E.C. Price 1s.

A popular treatise, on the telephone service, its past, present, and future, which may be confidently placed in the hands of the lay reader. The rise of telephony is explained, and the working and efficiency of modern systems clearly described in the first five chapters. The remaining five deal with general telephone questions and also the future possibilities of the system. The advice to subscribers may well be taken to heart by many, while other readers in the same category will feel conscience striken in seeing their sins enumerated in print. The volume seems to fulfil its object and should be well received by the general public. Something might have been said of the automatic, but perhaps this is regarded as an impossible freak.

"The Testing of Continuous Current Machines."

By C. KINZBRUNNER, A.M.I.E.E. London: Harper Bros., 45 Albemarle Street, W. Price 6s.

Here is a valuable work which students should find useful at all times. It appeals, especially, to those who are likely to engage in the testing of continuous current machinery. Dealing at the outset with the chief measurements to be taken, namely, of resistance, temperature, insulation, and speed it treats subsequently of no-load characteristics, load characteristics, magnetic measurements, and efficiency. Chapters on practical testing and the installation, care, and maintenance of machines bring the work to a close. We know of no other publication covering the same ground in the same comprehensive manner as the volume before us. Electrical and mechanical engineers and inspectors of electrical plant will find instructive data as to continuous current plant which may enable them to surmount many a difficulty.

"Elementary Manual of Steam and the Steam-Engine."

By ANDREW JAMIESON. Charles Griffin and Co., Exeter Street, Strand. Price 3s. 6*d*.

By the time a book has reached its tenth edition, as has happened in the present case, it is too well known to need much critical comment. It has enjoyed a deserved popularity for many years now, as a text-book for elementary students of the steam-engine, and the present volume does not greatly differ from its predecessors except that an appendix is added containing brief descriptions of the McInnes-Dobbie indicator, the Edwards air-pump, and the steam turbines of Parsons and De Laval. The questions culled from examination papers have been brought right up to date and the frontispiece this time is a coloured drawing of a Lancashire boiler and its setting. We think in view of its importance the steam turbine might have been dealt with a little more fully even in an elementary book. The sectional view of the Parsons' machine is extremely indistinct and the hazy illustration of the Turbinia going at full speed strikes us as a trifle superfluous. Almost all of lecture xviii. might, with advantage, be omitted, for the Newcomen Atmospheric engine and the single-acting engine of Watts now contain only historical interest, and we are even given detailed instructions as to how the latter may be started. If this space had been devoted to a description of the Willans or the Corliss or any other representative engine of the present day the student would have gained information of more practical value. We also notice two illustrations on page 218 printed upside down. Although we, perhaps, have dwelt rather on the faults than on the good features of the book, the latter are sufficient to justify a continuation of the favour which it has enjoyed.

Die elektrischen Anlagen der Schweiz.

First volume issued: Die elektrisch betriebenen Strassen-, Neben-, Berg- und Vollbahnen der Schweiz. By SIEGFRIED HERZOG. Published in Zurich by Albert Raustein. Price 18*s*. net.

Switzerland has always been looked upon as an important centre where electricity has found numerous applications, and many existing installations are considered as models of good and skilful engineering. The idea of collecting all the available information concerning the use of electricity in Switzerland is to be carried out in the publication before us, in three volumes, of which the first volume has already been issued, and deals with the electric tramways and railways of the country. There is hardly another country to be found in Europe where the conditions are more varied and require more than ordinary engineering skill to overcome them than Switzerland, the gradients being in some places exceptionally steep and the curves very sharp. In some of the railroads of the Swiss Alps the track has the resemblance to a ladder so sharp is the angle of the gradient. Acci-

dent is very adequately provided against, and it is the careful braking system which is responsible for that element of safety so characteristic of these mountain railways in Switzerland. The author has tried as much as possible to reproduce all drawings to a scale, ready to be used by others interested in carrying out similar work to that mentioned in the book. There are about fifty-eight installations described, some very fully, where a new system has been employed or some characteristic features had to be emphasised; others of familiar types were only casually touched upon to avoid useless repetition. It is not a very easy task to do justice to everybody in describing so many plants, and therefore shortcomings, if any, in this respect, may easily be overlooked. The book is very fully illustrated, and comprises 400 quarto pages and 533 illustrations. The majority of tramways and railways are using direct current at the present time, some use three-phase current conveyed direct to the motors on the car without rotary converters, while for others the three-phase current is converted to direct current by rotary converters, and in only one instance on an experimental short line high voltage single-phase current is used, as advocated by the well-known firm, Brown, Boveri. The same system is very ably advocated for in this country by Mr. W. M. Mordey, whose articles in this journal on the subject have been very much appreciated. There is a great likelihood that in the future single-phase motors will be more improved so as to be suitable for railway traction. The book can be recommended to all interested in the subject, forming as it does a valuable addition to the existing number of treatises dealing with the splendid installations erected in Switzerland.

The second volume, to be issued next year, will deal with the central power stations and power distribution, and the third volume will deal with the use of electricity for factory driving and industrial purposes generally. The author must be congratulated for the valuable information he has been able to collect, and put before his readers in such a lucid way.—L.G.

Short Notices.

Who's Who, 1905, 7s. 6d.; *Who's Who Year Book*, 1s.; *The Englishwoman's Year Book*, 1905, 2s. 6d. Adam and Charles Black, Soho Square, London, W. The 1905 editions of the above are to hand and amendments and additions have been made, bringing each volume right up to date.

The World's ELECTRICAL LITERATURE

The leading contents of the periodical electrical press of the world, papers read before Learned Societies, and any other literature treating upon electrical subjects are arranged *under subject-matter* in this section. Suitable references are made to the names and dates of the various papers, and the whole forms an index guide of considerable importance and value.

Power.

Articles.

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*High-speed Chain Drive in Motor Plants. G. Hill.	*Elec. Wrld. & Engr.* 19/11/04.
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Recent Developments of the Gas-engine. C. E. Walsh.	*Western Elec.* 12/11/04.
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Two Scottish Electric Power Schemes.	*Electn.* 2/12/04.
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Generating Set of the Sté. Alsacienne at St. Louis. Zweifel.	*Gen. Civ.* 19/11/04.
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A Large Gas-engine Electric Generating and Blowing Plant. F. C. Perkins.	*Elec. Rev. N.Y.* 26/11/04.
*Electric Power along Niagara Frontier.	*Elec. Wrld. & Engr.* 26/11/04.
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Papers.

Fuel Testing.	*Inst. of Marine Engrs.* 21/11/04.
*The Comparison of Vertical and Horizontal Tubes in Water-tube Boilers. W. R. Cummins.	*N.E. Coast Inst. Engrs. & Ship bldrs.* 25/11/04.
Motor Controlling Switch Gear. T. J. Pumphrey.	*I.E.E. Stdts.* 30/11/04
*Gas-engines for Central Stations. H. Campbell.	*I.E.E. Leeds,* 17/11/04.
Condensing Machinery. W. E. Storey.	*Soc. of Engrs.* 5/12/04.
Fuel Economy by Insulation. B. Lyddon.	*Inst. Marine Engrs.* 12/12/04.
*On Batteries with Reversible Boosters. C. Turnbull.	*Newcastle I. E. E.* 12/12/04.

Trade and Commerce.

Articles.

*Six Years of British and American Electric Export Statistics. W. P. Digby.	*Elec. Rev.* 25/11/04.

Papers.

*The Systematic Promotion of British Trade. B. H. Morgan.	*Soc. of Arts,* 23/11/04.

Electrical Work in the Shops.

Articles.

Electricity Leaflets. N. Harrison.	*Electry. N.Y.* 9/11/04.

Papers.

Premium System *v.* Piece-work System. G. T. Wood and J. P. S. Glover.

Articles marked with an asterisk are of exceptional interest, and well worth reading. Copies of any article or paper can be obtained on application to this office, a nominal fee only being charged for the clerical time occupied in taking out same. If desired, the whole publication will be procured (same not being out of print) on payment of the published price.

Where foreign papers have a similar title to those published in this country, the initial letters of the place of publication will be inserted after the abbreviated name of the particular paper; for instance, the English Electrical Review will be abbreviated Elect Rev., and the American Electrical Review, Elec. Rev. N.Y.

New Catalogues.

POWER.

Mining Plant.—The A. E. G. Electrical Co., of South Africa, Ltd. A carefully compiled and substantial publication relating to electrical power transmission in mines has reached us from the above Company. It contains illustrations of prominent plants installed in various parts of the world, these comprising apparatus for the complete supply of electrical energy as regards its generation, transmission, and utilisation. Prominent among the latter are numerous several interesting electrical winding plants. These, however, have received detailed attention at our hands in the first volume in Mr. P. R. Allen's special articles. The publication should be in the hands of every mining engineer.

Polyphase Motors.—Mather and Platt, Ltd., Manchester. A further addition to this firm's standard line of pamphlets is duly to hand. It deals with the Company's polyphase motors, and from it we gather that machines of the squirrel cage and slip ring type are made. It deals only with machines having short-circuited rotors. This type is standardised from 3 to 530 b.h.p. The list concludes with a price table of starting switches for these motors.

Polyphase Generators. — Mather and Platt, Ltd., Manchester. The second edition of this Company's polyphase generator list is now before us. The machines are all of the revolving field type for direct coupling, and are so designed that the pressure rise from full to no load does not exceed 6 per cent. with united power factor or 20 per cent. with 0.8 power factor. The list deals with standard machines from 75 k.w. to 1500 k.w.

Steam Turbines.—Hooven, Owens, Rentscher Co., Hamilton, Ohio, U.S.A. A comprehensive pamphlet dealing with Hamilton Holzwarth steam turbine has been forwarded from the United States. This contains a special description of this design of machine, and we gather that high and low pressure turbines are used in tandem on one shaft. From the ring channel at the head of high pressure turbines the steam flows through the first set of stationary vanes, these being rigidly connected to the head. It then passes in a full cylindrical belt interrupted only by the vanes of the first running wheel and thence to the following stationary vanes, and so on. The low pressure turbine is fitted with an additional nozzle which can be fed with live steam in case of overload. The stationary discs and running wheels are specially designed, and the subjects of separate patents. A special governor with regulating mechanism is also fitted.

LIGHTING AND HEATING.

Nernst Lamps.—Electrical Co., Ltd., Charing Cross Road, W.C. The above Company has just issued a special circular relating to the use of its Nernst lamps. It contains a number of useful tables comparing the cost of using these lamps with the ordinary incandescent burner. We referred in detail to these in our Lighting and Heating Section this month.

Carbons.—Henckel and Jordan, Baden. (Agent, M. Seeck, 6 Henrietta Street, W.C.) A complete list of the various types of carbons manufactured by this firm is given in a neat catalogue. Among these is a special flame carbon made to burn in three colours—yellow, red, and milk-white—for use in continuous and alternate currents. It is claimed that these carbons do not emit any injurious gases during combustion, they are therefore suitable for indoor lighting.

Arc Lamps.—General Electric Co., Ltd., Queen Victoria Street, E.C. Publication E. 1,062 is a bundle of leaflets stapled together and forming a complete price-list of "Angold" arc lamps. These are made in the open and enclosed types, while a midget form is also manufactured for continuous-current work.

British Thompson-Houston Co., Ltd., Rugby. A line of continuous-current series multiple lamps for running two in series on 200–250 volts, or five in series on 500–600 volts, is described in pamphlet No. 176. The lamps are made in three forms (1) with entirely self-contained line and substitutional resistances; (2) with self-contained substitutional and external line resistances; (3) with self-contained line resistance only.

Radiators.—The General Electric Co., Ltd., Queen Victoria Street, E.C. A neat pamphlet, No. 1,071, gives particulars and prices of the Company's Glow Type radiators. Our readers will be familiar with an elongated incandescent lamp with frosted globe arranged with some highly polished metal backing, and the various types put forward by the Company are examples of this kind made up in different sizes. Particulars are also supplied of radiators fitted with resistances embodied in enamel. In each instance current consumption is stated.

CENTRAL STATION PRACTICE.

Steam Drainage.—Ashwell and Nesbit, Ltd. A particularly handsome booklet has been sent to us by Messrs. Ashwell and Nesbit which deals with their Nuconomiser system. This has been designed to reduce the excessive waste of the water condensation from steam traps and steam mains. The illustrations of the apparatus are exceptionally well printed, and the principles of the system are lucidly explained. We give further details in Central Station Practice this month.

Recording Instruments.—J. H. Holmes and Co., Newcastle-on-Tyne. An eight page leaflet gives full particulars of a new line of Recording Instruments produced by the above

firm. These contain many novel features and are being put forward to supply a long felt want. In our Manufacturers' Section this month there is an illustrated account.

Switches.—J. H. Holmes and Co., Ltd., Newcastle-on-Tyne. The Holmes Page Quick Break Chopper Type Switches are described and illustrated in a recent pamphlet of the above Company. These have been specially designed to stand up against the excessive additions imposed by high pressure circuits. The enclosed type is very neatly arranged and should have an extended use as it is impossible to remove the cover while the switch is closed.

Electrical Instruments.—Crompton and Co., Arc Works, Chelmsford. Pamphlet No. U 11 gives concise details of the special line of moving coil instruments for which Messrs. Crompton have become famous. The method of constructing and calibrating the working element is treated in detail and will be found instructive reading. In the Manufacturers' Section this month an illustrated description of the complete cell will be found.

Small Engines.—Matthews & Yates, Ltd., Swinton, Manchester. A neat brochure dealing with this firm's "Cyclone" High Speed Engines has come to hand These have been specially designed for driving induced draught fans and dynamos. They are of the vertical double-acting type and are fitted with forced lubrication. A throttle governor is provided. They are made in standard sizes from 22 to 46½ h.p.

ELECTRICAL NOVELTIES.

F. Darton and Co., Clerkenwell Optical Works, E.C. A complete list has been issued by this firm detailing its manufactures in the way of Small Motors, Gas and Oil Engines, Batteries, Bells, Telephones, and Medical Coils. Our young readers would do well to study it before purchasing during the coming holiday season.

J. Haddon and Co., Salisbury Square, Fleet Street, E.C., have furnished us with their sheet A 61, describing a patent reducing scale which they have recently brought out. This is a very handy device for gauging the proportionate sizes of reductions and enlargements of prints, drawings, photographs, &c. In the publication and photographic department of any manufacturing concern it should prove of considerable value, and would, in fact, save its cost in time economise very shortly. From a specimen submitted to us for approval we have found the device very simple to manipulate, and effective in operation.

The *Forthcoming Event for 1905 is our Special Anniversary and Souvenir Issue (January).*

Don't *miss it.*

Forthcoming Events

Exhibitions.

Industrial Exhibition, Cape Town.
November 1904 *to January* 1905.

Tramway and Light Railway Exhibition.
July 3 *to* 14, 1905.

Meetings, &c.

The Institution of Mechanical Engineers. Session 1904-5.

Ordinary Meetings as follows:

1905. *January* 20. Friday.
February 17. "
March 17. "

The Institution of Electrical Engineers. Session 1904-1905.

1905	January	12	26
	February	9	23
	March	9	23
	April	13	27
	May	11	*25

* This will be the Annual General Meeting; the time and place will be notified to members hereafter.

Meetings of Local Sections.

Session 1904–1905.

	Birmingham.	Dublin.	Glasgow.	Leeds.	Manchester.	Newcastle-on-Tyne.
1905. January.	18	12	10	19	17, 31	16
February.	15	9	14	16	14, 28	6, 27
March	15	9	14	16	14, 28	20
April	12	13	12	13	11	—
May	10	11	10	—	—	—

Note.—The above dates are subject to alteration.

Manchester Section of the Institution of Electrical Engineers. Session 1904-1905.

January 17, 1905.—"Electric Driving in Textile Factories." H. W. Wilson, A.M.I.E.E.

January 31, 1905.—"Some Points on the Selection of Electric Cables." L. B. Atkinson, M.I.E.E.; C. J. Beaver, A.M.I.E.E.

February 14, 1905.—"Manchester Tramways Power Supply." S. L. Pearce, M.I.E.E.; H. C. Gunton, A.M.I.E.E.

February 28, 1905.—"Mechanical Construction of Steam Turbines." W. J. A. London, A.I.E.E.

March 3, 1905.—Annual dinner.

March 14, 1905.—"Low-Tension Thermal Cutouts." Professor Schwartz, M.I.E.E.; W. N. H. James.

March 28, 1905.—"Use of Electrical Energy in Mines and Collieries." M. B. Mountain, M.I.E.E.

April 11, 1905.—General Meeting.

Students' Section.

January 18, 1905.—"Notes on the Construction and Maintenance of Large Telephone Exchange Equipments." A. L. Stanton.

Manchester Students' Section.

January 13, 1905.—"Electric Heating." A. E. Jepson.

February 3, 1905.—"The Electric Equipment of Automobiles." V. H. Mahler.

February 24, 1905.—"Metallography." Mr. Buttenshaw.

March 17, 1905.—"High-Tension Switchgear." C. R. St. John.

April 7, 1905.—"Electric Cranes." M. Jennison.

Brighton Municipal Technical College Engineering Society.

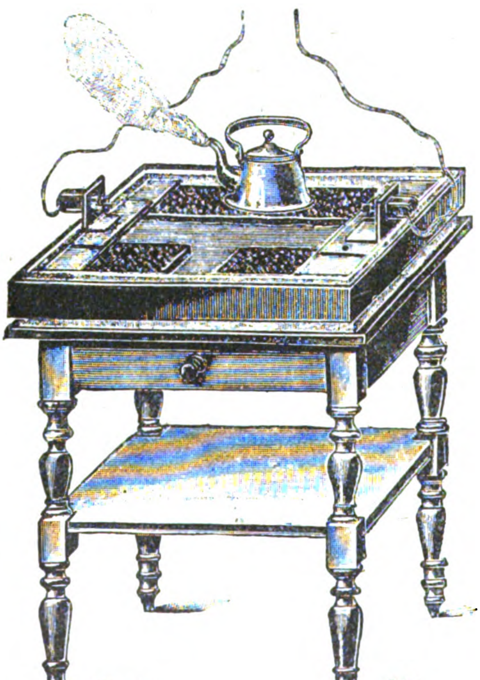
January 13, 1905.—"Steam Turbines." E. V. Caton.

Miscellaneous.

These notes are crowded out of the Lighting and Heating Section this month.

KRYPTOL: A NEW SUBSTANCE FOR ELECTRIC HEATING.

This material, which is to be used in heating appliances, is of German origin; its nature is not exactly known, but it is said to consist of a mixture of carborundum, graphite, and clay, so combined and graded as to form a powder of four degrees of fineness. It acts as the conductor in a resistance furnace, and our illustration shows the heating of a small



kettle by its means. The sides of the table contain carbon electrodes, and the kryptol powder forms a conductor of high resistance from one side to the other, and becomes incandescent as soon as the current is switched on. Naturally the kryptol retains its power better if it is enclosed in an air-tight chamber; but it is said that a radiator in daily use requires filling with fresh kryptol once in three months. It is not altogether certain what is meant by this last statement, and whether a cooking stove, such as we show, would work continuously all day for three months without attention is, we should say, very doubtful. The conducting power of kryptol would seem to depend on the existence of the graphite and carborundum in unaltered form, but both of them are oxidisable at a red heat. However, it is said to be largely empolyed in chemical laboratories for heating crucibles, &c., and in steelworks for various experimental purposes.

A Huge Electrically Illuminated Sign.

The Butterick Publishing Company of New York, thought that they would advertise themselves by means of the wall of their building which looks directly over the Hudson River. First they had the word "Butterick" painted in a dead black on the buff background of the building wall; the letters were of gigantic size, the letter B being sixty-eight feet high, the others fifty feet high and five feet wide. Then the further idea occurred to the management of illuminating this by night. At first it was though that it might be possible to illuminate the black letters by reflected light; but this was given up on mature consideration. It was then determined to outline the different letters by incandescent lamps; and then the question arose as to the candle-power and the spacing of the lamps. The choice was finally made of 4-c.p. lamps, spaced eighteen inches apart, and the effect is said to be very good. In this way the largest electrically illuminated signboard in the world came into existence.

The Illumination of the Nernst Lamp.

It is well known that there is a difficulty in comparing lights of different colours by the ordinary photometric methods. In America a new arrangement has been devised by the Nernst Company for determining the effective illumination of their lamps. A room, twenty feet by forty feet, is divided into two halves by a curtain down the middle; the one half is lighted by Nernst lamps, and the other by incandescent lamps, the two compartments being furnished alike with hangings of similar colour. It is then possible even for an unskilled observer to form an opinion as to the conditions under which the illumination in the two halves appears to be the same. In this way by taking the opinions of a large number of persons at random, it is believed that a fairly safe estimate is eventually reached. The result is that a one-glower lamp, taking about ninety watts, is equivalent in effective illuminating power to three 16 c.p. incandescent lamps; a three-glower Nernst lamp taking 264 watts, is equal to nearly ten incandescent lamps of 16 c.p.; a six-glower Nernst is rather better than a $7\frac{1}{2}$-ampere alternating-current enclosed arc, and the four-glower is equal to a 6.6-ampere alternating-current enclosed arc. It may be mentioned that the lamp has been used for lighting the Fine Art Galleries at the St. Louis Exhibition, and that it was preferred to the rival illuminants on account of the colour of its light.